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American Potato Journal

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COMPARATIVE STUDIES OF SEVERAL POTATO SEED TREATMENTS[1]

E. V. HARDENBURG

Cornell University, Ithaca, N. Y.

With the development in recent years of commercial hormone preparations for use as root stimulants, has come an increased interest in their use as potato seed treatments. Among those most widely used experimentally are rootone, transplantone, and tubertone, all carrying the hormone in the form of naphthyleneacetamide. Large increases in yield of potatoes from the use of tubertone dusted on the seed tubers have been reported by several experiment stations.

There is also a continuing interest in the possible need for minor or trace elements such as manganese, copper, zinc, iron and boron in the mineral nutrition of potatoes grown on certain soils. To safeguard the crop against this need, many fertilizer manufacturers incorporate some or all of these elements with the regular formula. Instances of inferior yields of potatoes caused by a lack of any of these trace elements in the mineral soils of New York are rare.

In 1943, a preliminary trial of rootone and of transplantone as hormone dusts applied to the cut and cured seed just before planting was made at the Cornell Experiment Station. In the same experiment was included a trial of a commercial mixture of trace elements sold under the name Es-Min-El. This mixture was composed of 55 per cent manganese sulfate, 25 per cent copper sulfate, 10 per cent zinc sulfate, 10 per cent ferric sulfate, and a small amount of boron. The Es-Min-El mixture was applied in the open furrow at rates of 50 and 100 pounds to the acre and thoroughly mixed with the soil just ahead of planting. Both rootone and transplantone were applied to the cut seed tubers at rates of 1 ounce and 2 ounces per bushel. In a single treatment, 1

[1]Published as Paper No. 272. Department of Vegetable Crops, Cornell University, Ithaca, N. Y.

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ounce of rootone applied to the seed and 50 pounds to the acre of Es-Min-El in the row were combined.

The 1943 experiment was planted on Allis gravelly loam soil having a pH range of 4.8 to 5.2 and which was in dry beans the previous year. Previous to planting, 1200 pounds to the acre of 4-10-10 fertilizer was broadcast and harrowed in. Each treatment or plot was planted in six replications in series, the rows being 50 feet long and 3 feet apart. The variety used was Mohawk; the season being favorable, early but very dry during August and September. The effects of the treatments on stand and yield are shown in table 1.

TABLE 1.—*Effect of hormones and minor elements on yield of potatoes* —1943.

Treatment	Stand Per cent	Yield in Bu. per Acre		Per cent No. 1 Size
		Total	No. 1 Size	
No treatment	81	144	135	93
Rootone 1 oz. per bushel	81	120	111	92
Rootone 2 oz. per bushel	73	104	94	90
Transplantone 1 oz. per bushel	75	130	122	93
Transplantone 2 oz. per bushel	89	158	150	95
Es-Min-El 50 lbs. per Acre	83	117	111	94
Es-Min-El 100 lbs. per Acre	78	115	110	96
Rootone 1 oz. plus Es-Min-El 50 lbs.	79	106	103	97
Least difference for significance with odds of 19 to 1	Not sig.	29	31	Not sig.

None of the treatments listed in table 1 significantly increased the yield over the untreated seed. Transplantone used at the rate of 2 ounces to the bushel of seed gave significantly better yields than rootone used at either rate. Rootone at the 2-ounce rate appeared to be toxic as it reduced the stand by 8 per cent and the yield significantly below that of the check. Es-Min-El at 100 pounds to the acre reduced the total yield below that of the check and when used at the rate of 50 pounds to the acre in combination with rootone at the 1 ounce rate, both total and No. 1 size yields were below those of the untreated seed.

SEED PREPARATION EXPERIMENT IN 1944

Several methods of preparing seed potatoes for planting are practiced by growers, some singly, some in combination. Among these are

dusting of the cut seed pieces with a drier to prevent "bleeding," curing of the cut pieces to develop a callus layer, and greensprouting. Results from such treatments, both in practice and experimentally, vary according to the condition of the seed when planted and according to the condition of the seedbed. Beneficial results from any one of them may not occur when seed and seedbed are ideal at planting time and when seasonal conditions permit of a full and complete growth period.

A comparative study of dusting, curing and greensprouting was made on the same soil as that used in the 1943 experiment. Hormone dust treatments with rootone and tubertone at the rate of 1 ounce to the bushel of cut seed were also included for comparison with the untreated fresh cut seed. Certified Green Mountain seed was weighed into 30-pound lots for each treatment on the 22d of May, just sixteen days before the planting date. Every effort was made to handle each treatment in the manner most practical for the potato grower. The methods of preparation, time of application, condition of the seed at time of planting, and the shrinkage in weight resulting from the treatments are indicated in table 2.

TABLE 2.—*Methods of treatment and condition at planting time on June 7, 1944.*

Treatment	When Applied	Conditions of Seed When Planted	Weight of Seed at Planting Date (Lbs.)	Shrinkage of Seed During Treatment (Per cent)
Check	Cut on 6/7/44	Firm — sprouts 2" long, most of which break off.	30.0	0.0
Cut and dusted, pulverized limestone, and stored in crate in dark at room temperature.	5/22/44	Fairly dormant, somewhat flaccid, no callus layer.	26.5	11.7
Cut and cured at 68° F. in crate covered with wet burlap.	5/22/44	Dormant and firm. Good callus layer.	29.0	3.3
Greensprouted, uncut on shelf near window at room temperature.	5/22/44	Greened sprouts about ¼ inch long and tubers firm.	29.5	1.7
Cut and dusted with Rootone.	6/7/44	Same as treatment No. 1.	30.0	0.0
Cut and dusted with Tubertone.	6/7/44	Same as treatment No. 1.	30.0	0.0

Of particular interest is the comparative loss in weight of the dusted, cured, and greensprouted lots during the treatment period. The losses in weight for these lots were 11.7 per cent, 3.3 per cent and 1.7 per cent respectively.

The experiment was planted on the 7th of June under ideal seedbed conditions. The plots were of single rows each 50 feet long, replicated five times and arranged side by side in series. It was thought best not to combine any treatments or to use a factorial design in this preliminary trial. It seemed best to first measure the effect on yield of single treatments before testing in combination. The growth period was extremely dry during August and September with the result that yields were relatively low. However, most of the plants remained alive until the date of harvest on the 11th of October. The effects of the treatments on stand of plants, rate of emergence, and yield are shown in table 3.

TABLE 3.—*Potato seed preparation experiment*—1944.
Ave. of 5 replications of 50 plants (50 feet) each.

Seed Treatment	Plants Emerged by June 28 (Per cent)	Plants over 4 Inches Tall on June 28 (Per cent)	Average Yield Per Acre (Bushels)		No. 1 Size (Per cent)
			Total	No. 1 Size	
Check	96.8	38.8	236	201	85.2
Dusted	98.8	42.0	249	221	88.8
Cured	97.6	47.2	239	191	79.9
Greened	99.2	62.0	256	211	82.4
Rootone	72.0	8.2	194	172	88.6
Tubertone	86.8	9.8	218	189	86.7
Least difference[1] for significance			28.5	24.0	

[1]At the 5 per cent-level or with odds of 19:1.

Compared with the untreated seed, stand of plants was not affected by dusting, curing and greening. Both of the hormone dust treatments definitely retarded the rate of emergence and reduced the final stand of plants. These effects were more pronounced from rootone than from tubertone. This may be explained on the theory that both of these root stimulants, were toxic to the sprouts or that by the time a root system was developed the hormone dust had been dissipated. Plants from the greensprouted seed emerged first and maintained this advantage through

most of the growth period in all replications. The difference in rate of emergence is best shown by the fact that on June 28, exactly three weeks after planting, 62 per cent of the plants from the greensprouted seed averaged over 4 inches in height as compared to only 38.8 per cent for the untreated seed.

Although the greensprouted seed gave the highest total yield, the advantage over the untreated, dusted, and cured seed was not significant. The deleterious effect of rootone on stand was sufficient to reduce the total yield of this lot significantly below that of all other treatments. In total yield, the seed treated with tubertone yielded significantly less than the greensprouted and the dusted seed. This hormone showed evidence of its potency as a root stimulant in that the plants of this lot made a very vigorous growth late in the season with the result that only the dusted seed gave a significantly higher yield of No. 1 size tubers. In terms of No. 1 size yield, the yields from the dusted, cured, and greensprouted seed were not statistically different from that of the untreated seed.

Conclusions

Trials during 1943 and 1944 of three commercial root hormones applied as dust to seed potatoes resulted in no increases in yield. Rootone and transplantone were compared in 1943, rootone and tubertone in 1944. Rootone retarded emergence, reduced the stand and appeared to be toxic to sprout growth. Es-Min-El, a commercial mixture of trace-elements, applied at rates of 50 and 100 pounds to the acre in the row and separate from the regular fertilizer application, showed no benefits. The conclusion is that this relatively infertile highly acid, gravelly loam soil was not lacking in these minor elements.

A comparison of cut seed dusted with ground limestone, cured seed, greensprouted seed, and freshly cut untreated seed resulted in no significant difference in stand of plants. Although the greensprouted seed emerged first, grew fastest early in the season and gave the highest total yield, the results were not statistically better than those from the dusted, cured and untreated seed. Profitable results from greensprouting, curing or dusting might be expected under less favorable seedbed conditions or in seasons less favorable to prolonged plant growth.

INTERNAL BLACK SPOT OF LONG ISLAND POTATO TUBERS

JAMES S. WIANT[1]

Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, Washington, D. C.

At irregular intervals during the last several years there have been received at the U. S. Market Pathology Laboratory at New York City samples of Long Island-grown Green Mountain potato tubers that were affected with an internal black discoloration at the time of their arrival on the market. On the basis of symptoms exhibited, the trouble was tentatively diagnosed as a type of bruising injury (1).

The occurrence of black spot in stored Long Island potatoes has been reported by Smith (2), and White-Stevens and Smith (3). For a number of years growers and dealers in Suffolk County have been familiar with the disorder which during some seasons has been of considerable economic importance. An internal black spotting of Washington potatoes that originated at the time of grading and which may possibly have been of a somewhat similar nature to the Long Island trouble was noted by Boyle (4). A number of Dutch and German investigators have described an internal blue or black tuber discoloration, the cause of which has been attributed variously to mechanical injury, to a deficiency of potassium in the soil, or to a combination of both. A search of the literature has failed, however, to reveal any report of a potato tuber disorder that appears to be strictly comparable with the black spotting occurring in Long Island tubers.

In January, 1944, black spotting of the outer tuber flesh became so prevalent in truckloads of Suffolk County potatoes delivered to the U. S. Naval Supply Depot at Bayonne, New Jersey, that a request was made for an investigation to be undertaken on the nature and cause of the trouble. The present paper summarizes such results of this study as were obtained during the latter part of the 1943-1944 storage period. The study was confined to the Green Mountain variety.

On a preliminary survey, visits were made to a number of potato growers in Suffolk County who had experienced difficulty. Black spot was noted in tubers that had been graded, sacked, and allowed to remain for one or two days thereafter in potato cellars. Practically no black spot was found in the ungraded tubers yet remaining in the same bins

[1]Associate Pathologist.

from which the affected lots had been removed. Many of the tubers in these bins, however, did show flattened or sunken areas apparently resulting from the pressure of adjacent tubers in the pile. These pressure areas or pressure bruises are illustrated in figure 1 and described more fully below. Mr. John L. Matheson,[2] Federal State Supervising In-

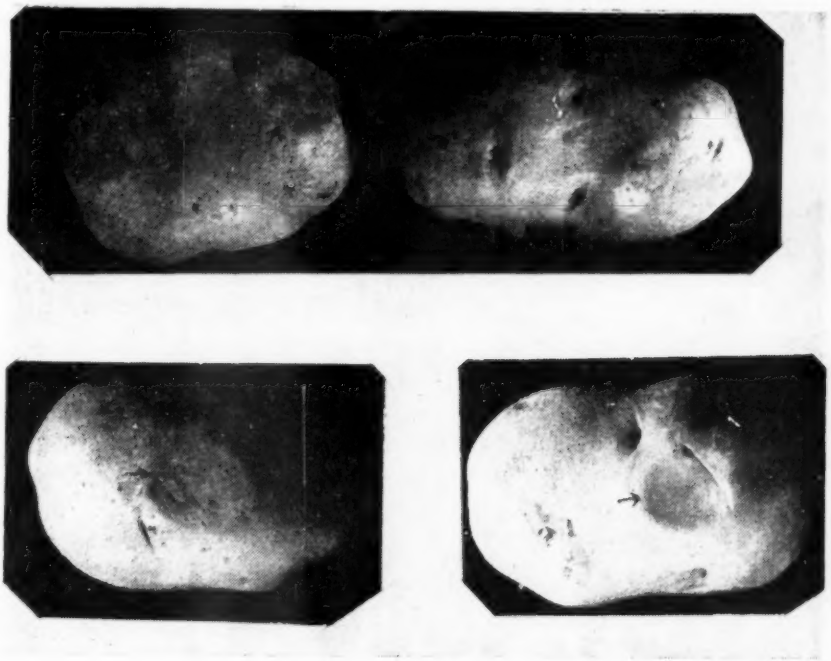

FIGURE 1. Pressure bruises that received no further injury. Flesh beneath pressure bruises free of black discoloration. Green Mountain tubers photographed five days after removal from face of pile.

spector for Long Island, who accompanied the writer, stated that for some years he and several of his associates had observed that pressure bruises played a part in the development of black spot. A number of tubers showing prominent pressure bruises were therefore collected and taken to the laboratory for later observation. During the course of a week at room temperature the pressure bruises tended to become less conspicuous and black spot developed only in an occasional tuber.

A series of experiments to determine the origin of black spot were then conducted in the vicinity of Riverhead with potatoes from three different bins. Tubers with conspicuous pressure bruises were in-

[2]Acknowledgment is here made to Mr. Matheson and inspectors under his supervision for lending aid and contributing many valuable suggestions in connection with the tests here reported.

dividually removed from their original position in the sloping face of the pile after grading operations had already begun. Replicate lots were selected. One was run over the grader once and a second lot twice, a third lot served as a check, while in a fourth lot each pressure bruise was struck rather firmly with the broad, smooth, rounded handle of a pocket knife. Upon cutting the tubers either one or two days later, it was found that black spot had developed beneath most of the pressure bruises struck with the knife handle. In those lots run over the grader black spot developed in varying degree under some of the pressure bruises; least was found in those run over the grader once, and most in those run over the grader twice. A small amount of black spot developed in the check lots.

In tests of another sort, replicate samples of potatoes with pressure bruises were carefully selected so as to avoid further injury of any kind and set aside at approximate temperatures of 38°, 50°, and 62° F., respectively. Representative tubers from each lot were cut at intervals during a period of one week. Only an occasional tuber was found to show any discoloration and then only in the form of slight blackening under a part of the pressure bruise. On several occasions a few tubers with severe pressure bruises were packed in cotton to protect them from bumps and other mechanical injuries while they were being transported to the New York laboratory. Some were held there at 40° F., others at room temperatures (70°-80° F.) for as long as eight weeks without evidence of black spot appearing.

The results of these tests showed conclusively that black spot could be produced by mechanically injuring the tuber at the pressure bruises and, conversely, that it failed to develop at the pressure bruises unless the tissues in those areas were mechanically injured after removal of the tubers from their original position in the bin. Small-scale tests made with tubers from widely scattered bins in Suffolk County have consistently confirmed the results obtained in the earlier tests referred to above.

By removing tubers individually from previously undisturbed parts of the pile it was repeatedly found that pressure bruises occurred only at points of contact between tubers. The size and shape of the pressure bruises varied with the extent of contact and the degree of pressure exerted against the tuber. Thus they ranged from approximately circular, slightly flattened spots one-fourth inch in diameter to large, flattened, somewhat sunken areas covering one-fifth or more of the tuber surface. The size of the pressure bruises, their degree of flattening, and their extent into the flesh of the tuber increased progressively from the upper part to the lower part of the bin.

The smaller pressure bruises on tubers from the upper part of the bin tended to nearly disappear within a few hours after the tubers had been removed from the pile. The larger ones likewise became somewhat less conspicuous, apparently through a resumption of the normal shape of the potato at the margin of the bruise after the pressure was removed. The outer flesh of the tuber at the pressure bruises was characteristically somewhat soft and pliable so that it could easily be slightly wrinkled or "piled up" by tangential pressure applied at the bruise.

The development of black spot at the pressure bruises was studied by cutting samples of potatoes at intervals from the time the pressure bruises were struck a blow with a blunt object until the time that maximum discoloration was in evidence. The first color change noted was the appearance in one or two hours, of a slight pinkish discoloration. Within four hours after injury the tissues were deep pink in color at the pressure bruise. After approximately six to eight hours the tissues, then much darker, were chocolate in color. Darkening progressed so that after approximately twelve hours the affected tissues were entirely a deep black without any trace of pink. Maximum discoloration occurred within twenty-four hours.

The symptoms of black spot in commercially graded potatoes were similar to those in tubers where the pressure bruises were individually mechanically injured. However, in commercially handled lots black spot was found developing in fewer of the pressure bruises and characteristically it affected only a portion of the pressure-bruised tissues.

By making successive tangential slices through the pressure-bruised area, discolored tissues could be found extending from near the surface to as deep as one-fourth inch or more beneath the surface. Blackening occurred either at one restricted area of the pressure bruise or over all of it, either uniformly or irregularly, depending undoubtedly upon the area of the bruise exposed to mechanical injury and the force with which any particular area of the bruise was struck. Blackened tissues were more or less normal in gross structure although they gradually dried out and became starchy. Eventually they became sharply delimited by cork tissue. Shatter-bruise type of injury with cleavage lines within the flesh ordinarily did not accompany black spotting.

The blackened area of the flesh may extend to the tuber surface although frequently it does not. In many instances there is no external evidence of black spot so that the discoloration is found only upon cutting the tuber. At other times the affected tissues and the tissues overlying them lose moisture rapidly and the surface of the tuber becomes sunken over the area of black spotting. This depression may be shallow or eventually as deep as one-sixteenth to one-eighth inch.

Frequently it appears as a smooth, rounded, roughly circular pocket although it may be linear or crescent-shaped. Often, instead of a single depression, there may be a continuous flattened area more or less roughened by irregular shallow identations. Although in time the black dis-

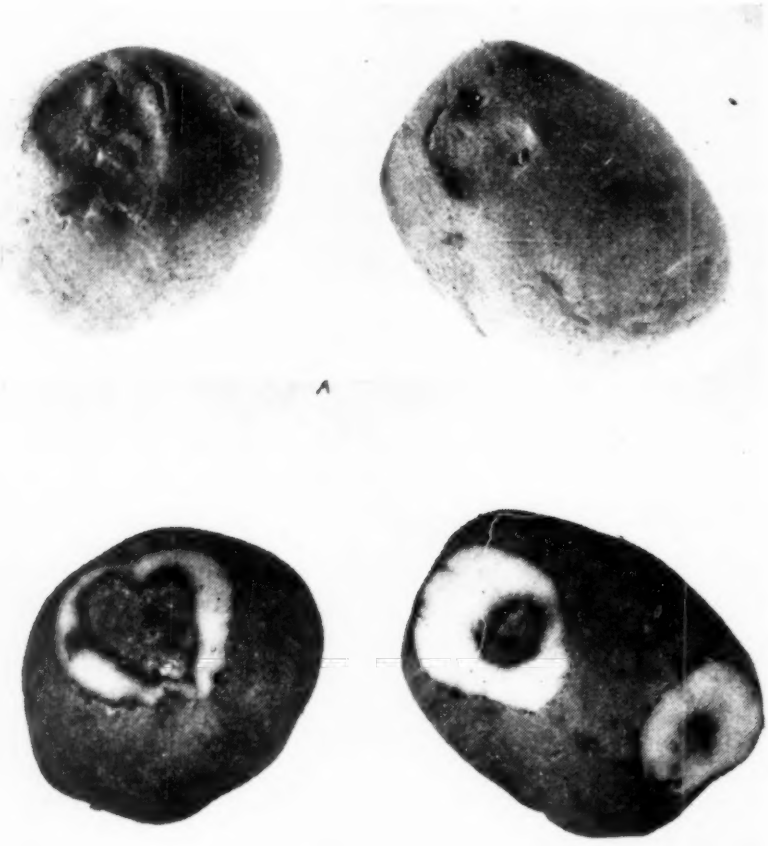

FIGURE 2. Black spot of Green Mountain tubers resulting from mechanical injuries to pressure bruises. A—External appearance. B—Internal appearance of same tubers shown in A.

coloration usually becomes less intense so that it is more nearly dark gray than black, it does not disappear once it has formed. Nor is there any evidence of progressive development or enlargement of the individual areas of black spotting. However, it has been found that pressure bruises retain for some weeks after removal of the tubers from the pile their ability to develop black spot following mechanical injury. There may thus be an increase in the amount of black spotting in a

given lot of potatoes if further mechanical injuries occur at the pressure bruises.

From a practical standpoint, however, it appears that most of the black spot found in commercial lots develops soon after the potatoes are graded and sacked and that it results from the mechanical injuries sustained by the pressure bruises during those operations. Internal and external symptoms of black spot are illustrated in figure 2.

There was no increase in number or size of blackened areas upon cooking badly affected tubers although the black discoloration was somewhat intensified, particularly while the cooked flesh was still moist.

Temperature was found to have an important effect on the development of black spot. Replicate lots of tubers with pressure bruises were held for three days at respective temperatures of 49°, 61°, and 67° F. At the end of that time they were run over the grader and struck on the pressure bruises with a pocket knife handle, after which they were returned to their respective temperatures for an additional day before cutting. Black spot was found to have developed in greatest amount at the lowest temperature and in least amount at the highest temperature.

Throughout most of the experiments all pressure bruises were marked with india ink at the time the tubers were selected from the face of the bin. Thus it became possible not only to follow the development of black spot at the pressure bruises but to learn as well whether it could originate elsewhere than at pressure bruises. On the basis of this first season's work it is concluded that although at times symptoms resembling those of black spot can be induced in certain potatoes by pronounced mechanical injury to normal areas of the tuber, from a practical standpoint nearly all black spot resulting from commercial handling originates at the pressure bruises.

The important role that pressure bruises play in the development of black spot appears to be clearly established. There remains unanswered, however, the question as to what conditions in turn predispose potato tubers to pressure bruises, and thus to black spot. No experimental data were obtained that would tend to answer this question. It would appear that any information of this nature would have a direct bearing on the control of black spot.

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JOINT MEETING OF THE POTATO ASSOCIATION OF AMERICA AND THE INTERNATIONAL CROP IMPROVEMENT ASSOCIATION

A joint meeting of the Potato Association of America and the International Crop Improvement Association was held at the Hotel Morrison, Chicago, Illinois, on the 4th and 5th of December. Certification officials, plant pathologists, horticulturists, seed growers and dealers to the number of approximately one hundred attended the various sessions.

Bruce P. Jones was chosen as Chairman for the Monday session, Marx Koehnke, Chairman of the Tuesday session, and E. B. Tussing as Secretary. On the 4th of December, the entire morning was spent discussing Bacterial Ring Rot and at the end of the session Chairman Jones appointed Mr. Keenan and Mr. Koehnke as a committee, with power to select additional members, for the purpose of discussing and making recommendations on potato ring rot. The committee consisting of the following members, W. H. Keenan, Marx Koehnke, E. L. Newdick, R. C. Hastings and H. N. Racicot presented the following report:

1. That ring rot is so widespread and prevalent complete eradication in North America is unlikely.
2. That areas apparently free should be protected in every way possible.

Recommendations:

1. That hope of commercial control lies in clean seed and that certifying agencies should maintain, or establish, a no tolerance policy.
2. That only new containers be used for seed.
3. That as infected table stock constitutes a serious menace to control efforts, the ideal seed production policy would involve:
   (a) No table stock to be planted on a seed-producing farm.
   (b) Separate storage for seed on the farm, in shipper's warehouses and in distributing centers.
   (c) Separate graders and general equipment for the handling of seed.
   (d) A campaign of eradication in the main seed-producing districts.
   (e) The annual sterilization of all second-hand bags, boxes, barrels, crates, planters, diggers and storages on each seed-producing farm located in these infected areas.
   (f) Supervised clean up and new seed in all cases of infections on seed farms.

4. That since second-hand bags are regarded as an important source of contamination it is advisable, in the interests of ring rot control and to protect table stock growers, to consider appropriate legislation to require that all wholesale second-hand bag dealers shall disinfect and certify under supervision all used bags placed on the market.

Mr. Werner moved, seconded by Mr. Goss that the report be accepted and sent to the Potato Journal for publication. Motion carried.

Following the discussion on War Approved seed Mr. Newdick moved, seconded by Mr. Hyland, that the group go on record as supporting the OPA Industry Committee's recommendation that the War Approved Seed Program be discontinued in 1945. An amendment was offered by John Zuckerman to read that the group go on record supporting the OPA Industry Committee's recommendation that the War Approved Seed Program be discontinued in 1945 providing that the War Food Administration concurs that certified seed production is ample and that the War Approved Seed Program is not needed. The motion, as amended carried.

Before the meeting adjourned, there was a discussion about a meeting for 1945. The question was whether the Potato Association should hold its meeting at the time of the A.A.A.S. meeting or meet with the International Crop Improvement Association. Mr. Hankins moved, seconded by Mr. Newdick, that this group go on record as recommending to the Potato Association's Executive Committee that the Potato Association meeting be alternated with the A.A.A.S. and the International Crop Improvement Association.

E. B. TUSSING, *Secretary.*

In his report of the meeting, Bruce P. Jones, Chairman of the I.C I.A. Potato Committee, stated that although the annual meeting of the International Association was concerned largely with the subject of minimum seed standards for the many kinds of seed crops now being certified in North America, the seed potato section devoted most of the two days to the subjects of potato diseases, the values and tolerance of which constitute a major part of all seed potato standards, and to the subjects of insect control problems, ceiling prices and the special emergency class of seed known as War Approved Seed. A preliminary survey of state seed potato standards was started, but, inasmuch as this was only the second meeting of this group, no recommendation on a minimum standard was made. However, this is an important subject which undoubtedly will be considered further in the next meeting. There is great need for more uniformity in seed standards and in interpretations.

A conference of this kind, where seed growers and seed users; state, federal and dominion inspectors and certification officials and officials from consuming states; extension workers and research workers, all meet together and freely discuss common problems, should be a most opportune occasion to discuss standards and to make real progress in the seed potato industry.

On Wednesday morning, the 6th of December, there was an interesting and instructive tour of the Chicago potato markets. This was arranged and conducted by the members of the Chicago office of the War Food Administration and the Chicago Market Association cooperating with the International Crop Improvement Association. Forty-two persons went on the tour. First, the Chicago & Northwestern Railroad trading yards of the Wood Street Terminal were visited. Here the group had an opportunity to see carlot arrivals from many important potato-producing sections of the country. The group was then transported to the South Water Market and assembled at the headquarters of the South Water Market Credit Association where the Secretary of the Association explained that market set-up. Small groups, each with an official instructor, were conducted throughout the market, including the Fruit and Vegetable Branch office of the United States Department of Agriculture.

The general session of the International Association was held on Wednesday and was concluded with the annual banquet in the evening.

Under the leadership of the persons indicated there was a full and free discussion of the following subjects.

RING ROT PROBLEMS.....E. L. NEWDICK, Maine
FOUNDATION SEED PLOT WORK.....HENRY DARLING, Wisconsin
INSECT CONTROL PROBLEMS.....H. D. TATE, Nebraska
WAR APPROVED SEED POTATOES.....A. G. TOLAAS, Minnesota
CEILING PRICES FOR SEED POTATOES.....H. J. EVANS, New York
LATE BLIGHT.....REINER BONDE, Maine
NEW AND UNUSUAL DISEASES OF POTATOES....R. W. GOSS, Nebraska
NEW VARIETIES OF POTATOES.....H. O. WERNER, Nebraska

It has not been possible to secure copies of all the reports, but those available are printed below since they are certain to be of interest to everyone concerned with the potato crop. Additional reports, as they become available will be published in later issues of the Journal.

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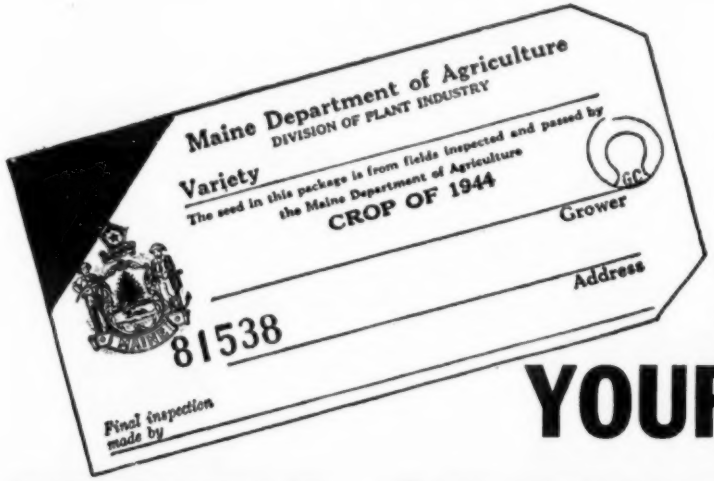
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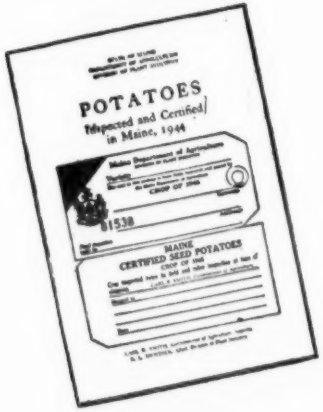

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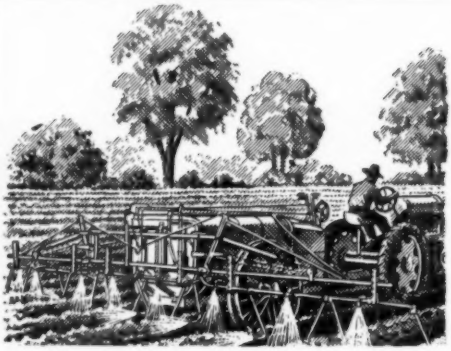

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Insect Control Problems

H. DOUGLAS TATE

The discussion revolved principally around the following four points: 1, a shortage of certain insecticides and replacements or substitutes for them; 2, new and recently developed insecticides, including DDT, sabadilla, Lethanes and dinitro compounds; 3, availability of materials; 4, 1945 recommendations for controlling potato leafhopper outbreaks such as occurred in some of the midwestern states in 1944.

Lack of pyrethrum in 1944 for inclusion with other materials to reduce heavy leafhopper populations was an important factor toward extensive losses resulting from leafhopper damage in some midwestern states. In some of these areas where potato leafhoppers are not a constant problem the seriousness of the situation was not appreciated until heavy populations had developed, and available materials were not adequate to satisfactorily handle the situation.

Several workers who have been conducting research with DDT (dichlorodiphenyl-trichloroethane) reported it as being very promising for all of our major potato insects, including flea beetles, potato leafhopper, psyllids, Colorado potato beetle and certain other species of leafhoppers and mirids. It was reported as superior to other commonly used materials in concentrations as low as a 1 per cent dust for leafhoppers. Although somewhat slower in action, a 1 per cent dust was effective for the Colorado potato beetle. However, a 2 to 3 per cent dust was indicated as a commercial recommendation on potatoes at present. In view of the fact that DDT affects insect predators and parasites, it was pointed out that wide scale usage of this material might possibly upset ecological complex to such an extent as to present a serious problem.

Sabadilla was reported as effective in dust form for the potato leafhopper at relatively high concentrations, 10 per cent. Certain dinitro compounds and "Lethanes" were reported as promising materials for leafhopper control.

In case pyrethrum and DDT are not available in 1945, Bordeaux mixture spray, plus nicotine sulphate for quickly reducing heavy populations, was suggested for leafhopper control. The need for early treatment was emphasized.

The belief was expressed that the golden nematode, now restricted to a small area on Long Island, is a pest of considerable importance to the potato industry. It was suggested that vigorous action should be taken to prevent its spread.

War Approved Seed Potatoes

A. G. TOLAAS

The reason for including a discussion on War Approved Seed Potatoes at the Chicago meetings on the 4th and 5th of December, as I see it, was to determine the attitude of certifying agencies of the country toward this type of seed potato production.

Possibly a brief summary of the purpose behind the OPA regulations, which established the designation War Approved Seed Potatoes, might be worth mentioning. In 1942, 371 million bushels of potatoes were produced in the United States. Of this production 20.5 million bushels were certified seed, leaving 350 million bushels for consumption. The production of less than 360 million bushels means a shortage in table potatoes,—and since the armed forces were using more potatoes, and because potatoes were no doubt being shipped abroad, our home demand could not be taken care of properly. The production of 20.5 million bushels of certified seed potatoes, although the largest since seed potato certification was established, was far below the requirements necessary for planting the 1943 crop, and the seed potato situation became particularly acute inasmuch as the Government requested potato growers of the country to increase their potato plantings. The apparent lack of enough certified seed with a subsequent demand for more seed,—particularly during the months from January through March 1943,—and priority over table potatoes being granted for seed stock, were undoubtedly responsible for many carloads of potatoes leaving the main producing areas as seed. The increased demand for seed stock prompted a lot of promiscuous tagging since it did not take long before such stock was selling for a premium. However, the factors just mentioned soon created a shortage of table potatoes and put a lot of potatoes of questionable value on the market as seed potatoes. This is not a particularly unusual procedure in years when the crop is short. The OPA through a rather involved process tried to control this problem.

In order to prevent flooding the country with questionable seed stock for future planting, several OPA meetings, attended by representatives of certifying agencies, dealers and growers and designed to set up some definite system of seed potato distribution and price controls, were held during the summer of 1943. As a result of these deliberations, the War Food Administration set up rules, regulations and standards for the certifying agencies to follow in the inspection and certification of war approved seed potatoes. Although these standards came out too late to carry out the provisions to the letter, the certifying agencies did the

best they could under the circumstances. As far as price controls were concerned, the ceilings finally adopted were: none for foundation stock, $1.00 per cwt. for certified above U.S. One table potatoes, and 50c per cwt. for war approved seed above U.S. One table stock.

There was some opposition to field, or even bin, inspection by certain individuals in the trade in view of the lateness of the season which made adequate inspections on some fields impossible. It was quite evident that some of these interests wanted the certifying agencies to be merely tag-issuing agencies without any official state control except that involved in making grading inspections. Naturally, in order to make the program work satisfactorily and to make it possible for the growers to get at least part of the premium, it was absolutely necessary for the certifying agencies to maintain control over the seed which was to be tagged.

As a result of the seed potato program in 1943, 29 million bushels of certified and 12.5 million bushels of war approved seed potatoes were produced. Reports from certifying agencies indicate that the number of cars of war approved seed potatoes shipped was not a particularly large percentage of the seed produced. These agencies also reported that the production of war approved seed in their respective states in 1944 was considerably lower than in 1943, the total production being about 20 per cent of what was produced last year. Maine had no war approved seed in 1944.

At the potato meetings held in Chicago last year in connection with the meetings of the International Crop Improvement Association, at which 13 certifying agencies were represented, the tolerances governing the growing of war approved seed potatoes this year were considerably tightened.

With respect to the production of war approved seed potatoes this year, most states which engaged in the program made field inspections under proper conditions (Minnesota required two such inspections). Fields failing to meet the certification requirements, but which met the tolerances for war approved seed, were classified as such. If the program is to be continued, it was apparent from the discussion on the subject this year that this same practice would be followed.

It was pointed out in the discussion that many growers in 1943 did not understand the program, being under the impression that, by registering with the certifying agency and paying certain fees, the federal government would pay them a premium of 50 cents per cwt. for their potatoes. Many were disappointed. Some agencies reported that the war approved seed program had been responsible for getting high class

table stock growers interested in growing certified seed. The fact that seed potatoes had priority enabled certain dealers to obtain cars for war approved seed potatoes when they could not obtain them for table stock. No doubt some of these cars went on the table market.

The group voted that the war approved seed potato program be discontinued unless the W.F.A. deems it necessary that more seed potatoes than the certified seed potatoes produced will be required.

RING-ROT PROBLEMS

G. H. STARR

SUGGESTIONS FOR GROWING RING-ROT-FREE POTATOES

A. *Where grower has ring-rot in the potatoes that he now is growing.*

1. Dispose of all potatoes known to contain ring-rot and do not use any for seed the following year.
2. As soon as the crop is removed from storage, clean out all bins and the entire storage cellar where ring-rot infected potatoes have been stored. Ventilate well to allow all surfaces to become dry.
3. Disinfect the cellar thoroughly by spraying the soil, bin boards and all surfaces that have come in contact with the stored potatoes. Copper sulphate (1 pound to 10 gallons of water) or formaldehyde (1 pint to 15 gallons of water) may be used. Chlorinated compound such as B-K and others have been used successfully for this purpose. For a 2000 pp.m. of B-K use 6½ ounces per 10 gallons of water. These should probably be recommended in the order given. After spraying, the cellar should be closed up tightly for several hours, especially where formaldehyde or chlorine compounds are used. Later, it should be ventilated to dry it out.
4. Disinfect all equipment that has been used in connection with the digging, sorting and storing of the potato crop.

   a. For sack disinfection, steam sterilization is recommended where available. A few minutes' exposure to steam will kill all ring-rot bacteria Copper sulphate (at strength given above) may be used especially on older bags if the discoloration of the bags is not considered as impairing their value In using copper sulphate, soak the bags well in the solution for a few minutes, drain off and spread out to dry. If formaldehyde is used, soak the bags in the solution (of strength given above) for a few minutes, drain off excess solution and cover for one hour or more to allow fumes to act. Later, spread out to dry. Mercurnol or any other acid solution should not be used on burlap bags.

b. For baskets, sorters and similar equipment copper sulphate, formaldehyde or chlorine compounds may be used as disinfectants. Where either formaldehyde or chlorine compounds are used, the spraying can best be done in the cellar at the same time that the cellar is disinfected. This gives a better concentration of the active vapors with more effective results.

c. For the disinfection of planters and diggers, copper sulphate may be used at the strength previously mentioned. All parts of these machines that come in contact with the potato seed pieces should be thoroughly sprayed with the disinfectant.

Where two or more seed lots are to be planted, such as foundation seed and a questionable lot, the better seed should be planted first and the questionable one last, in order to avoid a possibility of ring-rot spread.

5. Secure the best certified or foundation seed that can be obtained in the state. This should be sufficient to plant an acreage that will produce enough seed potatoes for your entire acreage the following year.

a. Do not store such potatoes in your cellar with other potatoes of questionable ring-rot content. If possible, place new seed in storage where ring-rot has not been present in the past or, if present, has been completely eliminated by thorough disinfection.

6. If a seed lot contains soft-rot tubers which contaminate other tubers with a slimy ooze, it is best to treat this seed about two weeks previous to planting time with corrosive sublimate (Mercuric chloride) 1:500 or 4 ounces to 15 gallons of water for 20 minutes or with acid-mercury (Mercurnol) for a period of 3 minutes.

7. Plant certified or foundation seed in fields well isolated from others. *This is important.* Too often growers will get the best seed obtainable and then plant it along side of potatoes containing ring-rot or virus diseases, thus contaminating the better seed.

B. *Where the grower does not have ring-rot in his present potato crop.*

1. Practice sanitation and disinfection of storage cellar.

2. Do not store other potatoes of unknown ring-rot content in your own cellar.

3. Caution visitors or buyers who may wish to cut potato tubers in your cellar not to use a knife that may be contaminated with ring-rot bacteria from other cellars.

4. Do not borrow planters, diggers, sorters, picking bags or any other equipment from your neighbor nor permit him to borrow yours. Ring-rot bacteria may be introduced in this way.

5. Do not purchase new lots of seed potatoes just to see what they are like. So often, ring-rot and other diseases are introduced in this manner. When you get good seed, stick to it and exclude seed from other sources.

C. *Suggestions for reducing ring-rot in commercial plantings where seed is known to contain some ring-rot.*

1. Treat seed potatoes with acid-mercury (Mercurnol) two weeks before planting, as directed under A-6.
2. At planting time, cut the potato tubers with a rotary cutting knife where the cutting surface is disinfected by running in a chemical solution (mercuric chloride) or preferably, in a bath of boiling water.
3. If the rotary knife is not available, the seed may be treated after being cut by dipping in corrosive sublimates (1:500), 4 ounces to 15 gallons of water, for a period of 5 to 10 minutes.

   This seed should be planted right after treatment or spread out to dry if the planting process is delayed. (The treatment of cut seed is limited in its use, as in some parts of the country, reduction in stands result.)

D. *Eliminating ring-rot by hill-selection.*

If a small amount of ring-rot is found in an otherwise desirable strain, it is possible to select healthy hills from fields planted with such seed and thus eliminate the ring-rot disease.

In some cases re-selections may have to be made as some of the original hill units may have had slight ring-rot in them.

E. Reducing ring-rot by roguing.

Where a small amount of ring-rot is found in a potato field and the potato crop is to be put in storage, it will be advantageous to rogue out ring-rot plants, removing all the tubers. If such infected tubers are not removed, they will break down in storage, be disagreeable to handle and cause much loss. This method is not practical where ring-rot reaches considerable proportions.

F. Miscellaneous information on ring-rot.

1. Disinfectants tested as bacteriocides in 10-second exposures.

   a. Effective:
      1. Mercuric chloride (1 pint to 15 gallons).
      2. Acid-mercury (Mercurnol).
      3. Boiling water.
      4. Furfuryl alcohol (full strength).
      5. Iodine.
      6. Lysol (3 to 5 per cent).
      7. Kreso dip (3 to 5 per cent).
   b. Moderately effective:
      1. Phenol (1 per cent).
      2. Copper sulphate and tri-basic copper sulphate (1 lb. to 10 gal.)
      3. Ethyl alcohol (70 and 95 per cent).
      4. Mercuric oxide.

5. Chlorine compounds.
   a. B-K (2000 to 8000 ppm.).
   b. Steri-chlor (2000 to 8000 ppm.).
   c. Casklor (2000 to 8000 ppm.).
   d. HTH (2000 to 8000 ppm.).

c. Slightly effective to non-effective:
   1. Sodium chloride.
   2. Soap (Ivory).
   3. Wettable sulphur.
   4. Cinnex 20.
   5. Semesan Bel.
   6. Formaldehyde (1 pint to 15 gallons).
   7. Fermate.
   8. Spergon.
   9. Thiosan.
   10. Arasan.

2. Effect of freezing.

Ring-rot bacteria will remain viable in infected tubers frozen continuously for several months.

PREVALENCE OF RING ROT IN CERTIFIED SEED PRODUCING AREAS IN THE UNITED STATES AND CANADA

MARX KOEHNKE

During August, 1944, at a conference of potato workers assembled at Fort Collins, Colorado, the need for further information on Bacterial Ring Rot in relation to certified potato production was deemed advisable. A survey on Ring Rot had previously been made by a special committee set up for this purpose (Goss, Leach and Dykstra) in the Phytopathological Society. Since this information has not been kept up to date, a new survey was suggested.

Each state producing certified potatoes was asked to report on the condition within their state. The reporter was asked to summarize information for the past five years, including the current season, giving the percentage of fields entered for certification that were rejected for Ring Rot. The report includes the average per cent of Ring Rot found; —however, this might be stated as the range of per cent as noted in various inspections.

The table which follows is listed by states, in alphabetical order, but the name of the state is not given. It was considered advisable to withhold the name of the state, because of reluctance on the part of some to release this information for general dissemination.

It should be noted that states No. 4, 7, 12 and 19 in the table have a very small production, and all of this stock is absorbed within the producing area.

RING ROT SURVEY

State	Per cent Fields Entered That Were Rejected for Ring Rot					Average Per cent Ring Rot Found
	1944	1943	1942	1941	1940	
1.	9.6	10.0	3.3	4.5	No Record	0.2 to 2 per cent
2.	2.4	10.0	2.6	3.1	7.4	Slight to abundant
3.	6.8	11.0	1.2	0.8	3.4	Trace to 1 per cent
4.	13.7	....	....	....	....	Not given
5.	2.9	3.7	1.8	0.7	2.1	Trace
6. By Acres	7.8	5.8	5.1	4.1	5.4	Trace to 1 per cent
7.	None	None	None	None	None	
8.	15.5	4.4	3.4	7.2	0.7	Trace
9.	19.8	7.4	10.9	3.1	6.1	0.3 per cent (1944 Only)
10.	None	0.2	1.1	1.1	2.0	Trace to 2.0 per cent
11.	10.0	1.8	2.0	7.1	0.6	Trace to 5.0 per cent
12.	None	None	None	None	None	
13.	3.1	1.1	0.3	2.0	3.8	Trace
14. By Acres	17.7	13.3	12.6	13.4	20.3	Trace to 0.1 per cent
15.	3.6	2.7	3.9	4.4	3.2	Trace
16.	10.0	14.8	6.8	11.6	No Report	Presence causes rejection—No per cent given
17.	None	1.2	None	None	None	Not given
18.	1.6	2.4	4.1	5.8	10.6	Trace to 2.0 per cent
19.	5.6	7.6	None	2.3	2.3	Less than 1.0 per cent
20.	1.2	1.6	None	1.4	10.0	0.5 to 2.0 per cent
21. By Acres	9.1	19.4	6.2	6.9	No Report	Trace to 0.5 per cent
22.	8.4	7.6	5.3	13.4	23.5	Up to 1.8 per cent
23.	2.2	2.2	4.8	5.0	2.4	Usually traces

FURTHER NOTES ON RING ROT SURVEY

In replying to the questionnaire on Ring Rot, many of the individuals reporting, gave rather detailed information and side lights on their own particular states. As far as possible, this information is included below.

Numbers preceding paragraphs refer to states with corresponding numbers in the table, and give additional information in answer to the following questions:

(A) What progress is being made in eradication of Ring Rot in seed potato area?
(B) What methods are being used to eliminate the disease?
(C) Which is most effective?

(1) (A) Just about holding our own.
(B) Obtaining clean seed and seed treatment.
(C) No lot is planted from seed that is known to have Ring Rot, but it seems as if we have about that many escapes each year, and new contaminations.

(2) (A) Good progress. In any severe disease situation, flare-ups may be expected before the quantity has been reduced to a minimum. Such flare-ups occurred in 1943.
(B) Seed certification has been an effective means in holding down the disease. It is the only means employed except some educational work.
(C) Seed certification.

(3) (A) Have been able to eliminate from several special lots.
(B) Greenhouse and field plot index, hill selection by stem readings or by staining and reading under the microscope.
(C) Questionable, but probably hill selection by stem reading.

(4) (A) None.
(B) Buying seed certified as being free from Ring Rot.
(C) We have had a great deal of trouble from Ring Rot, and are just about out of the Irish seed potato certification program. We were not able to certify any seed in 1943, and only about one carload in 1944.

(5) (A) Growers in seed-producing areas who have had Ring Rot are doing an excellent job of cleaning up in most cases, by getting rid of their seed, disinfecting all equipment and cellars, and starting with new, clean seed lots. Some of our outstanding growers now are growers who have had Ring Rot infection in the last few years. Several of the fields showing Ring Rot in 1943-'44, were in commercial districts,

where growers attempted to produce seed. Two communities have started general community cellar disinfection clean-up programs. We feel that we are holding our own, or gaining a little on Ring Rot in general, as far as seed production is concerned.

(B) Thorough inspection and rejection of all lots showing any amount of Ring Rot. Thorough clean-up and disinfection. Community effort in disinfecting cellars.

(C) Elimination of seed lots containing Ring Rot.

(6) (A) No progress. We are getting worse.

(B) Disease-free seed is the only method that we know anything about and the practice of selection to prevent infection.

(C) We have not proven that diseased stock can be cleaned up.

(7) No comments.

(8) (A) First found in 1939 in table stock. Generally not found in field until 1944, but rejection usually made at bin or carlot inspection.

(B) Growers urged to disinfect all equipment, and secure new, clean stock. Personal contact and by special meetings. Posters giving high points used. Inspection of seed lots at planting time. Expansion of planting tuber-unit seed plots with clean seed being urged.

(C) Some spread due to infected lots being sold as seed instead of table stock. Much spread in warehouses.

(9) (A) We thought we were making progress until this year.

(B) All of the precautions we can think of, plus special literature are given to all certified seed growers, both old and new.

(C) Some growers, who in the past, have had Ring Rot, and who have followed the customary precautions, have gotten rid of it, and have had no further trouble.

(10) (A) Good progress in both seed and table stock. Disease has never been found in some seed-producing areas, and every precaution being taken to prevent its introduction.

(B) Maintenance of zero tolerance in certification regulations. Recommend disposal of all stocks on a farm, if Ring Rot infection is found in any. Thorough cleaning of premises and disinfection of cellars and equipment.

(C) New, clean seed and sanitation. Avoid use of old potato bags,

(11) (A) Most in new seed—some in uncertified. A couple of years ago it was my belief that progress had been made in the Ring Rot picture, but I am not so sure now that too much

ground has been gained. I believe that there is a lack of basic information as to how Ring Rot is disseminated.

(B) Dispose of diseased plants and tubers. Knives and tools disinfected. General sanitation.

(C) Hard to say. Mostly in new seed, even tuber-unit Foundation,—others may be from cutters.

(12) (A) Very little local production. Most seed shipped in.

(13) (A) Feel most of seed potato areas are free from Ring Rot. Seed growers discard seed when found. Table stock growers in most areas tend to use certified seed.

(B) No systematic program. Growers are advised to replace infected stock and disinfect equipment. These methods commonly adopted but not, of course, by every grower.

(C) Above plan has been effective where tried. Experiments indicate disinfected rotary knife effective in limiting spread. Seed treatment also effective in limiting spread but injurious.

(14) (A) Some. Common potatoes need attention.

(B) Use of disease-free seed, disinfection and sanitation.

(C) Use of disease-free seed and sanitation.

(15) (A) We have one main seed-growing area where Ring Rot has never been found.

(B) No potatoes can legally be sent into that area for either table stock or seed without a field inspection by State College people and a Ring Rot-free certificate. When Ring Rot is found in seed, that grower gets rid of his entire seed lot and purchases a lot known to be Ring Rot-free. Rotary cutting knives are used by some growers—the knife passing through disinfectant. One group of Foundation seed stock, eye index and incubate the stem end of each tuber in the seed plot. We have tried the ultraviolet light, but are not very well satisfied.

(C) Get rid of infected seed,—and disinfect everything.

(16) (A) Infection appears to be more general than it was several years ago.

(B) Planting seed from sources that are thought to be free from Ring Rot.

(17) (A) Fields are inspected at digging time, and also in the bin. Then all certified seed is inspected in the car.

(B) Seed stocks are checked. Old racks cannot be used on seed stocks.

(18) (A) Excellent, as above mentioned reports bear out.
(B) Disease-free seed, crop rotation, seed treatment, sanitation, use of new bags.
(C) Disease-free seed, sanitation.

(19) (A) Disease persists in previously infected seed sources and occasionally makes its appearance in a new source.
(B) Only the zero tolerance in certified seed standards. In the meantime infection in table stock lots has been generally increasing and there is reason to believe Ring Rot has been widely distributed in "selected seed."

(20) (A) No tolerance permitted.
(B) Strict sanitation—seed source carefully guarded.
(C) Both necessary, together with eternal vigilance.

(21) (A) Good, but slow. This is only data on certified seed. Ring Rot more widespread in state than indicated, particularly in commercial and table stock plantings.
(B) Sanitation and clean seed.
(C) Inseparable.

(22) (A) Steady progress being made; growers realize importance of disease-free seed and other methods of control to prevent Ring Rot.
(B) Better Foundation seed, disease-free (we hope); sanitation and disinfection of cellars and equipment.
(C) Disease-free seed—but other control methods have to be practiced to prevent it from becoming infected with Ring Rot.

(23) No comments.

(24) This state did not submit information in time to include in the survey. Advised that they had it in both table stock production and in some of their seed stocks. "I have had to turn down a considerable number of fields this year, due to the fact that there were just a few plants in such fields. The fact of the matter is that I turned down one field in which I found no Ring Rot, primarily because I found it in the parent seed stock."

Reports were received from two southern states. The Hastings section of Florida reported that Ring Rot has caused very little loss since 1940. They state that they must rely upon seed growers to produce and sell seed free from Ring Rot.

In the case of Louisiana, State Inspectors check all cars of seed potatoes brought into the state. We quote: "When suspicious Ring Rot tubers are found by inspectors, they are forwarded to the Plant Pathology Department for staining verification. If staining reaction is positive, cars are rejected for seed purposes. On the above information, the following rejections are made:

1944, 13 1943, None 1942, 5 1941, 7 1940, 9

One very obvious fact has been brought out by this survey. Ring Rot is on the increase in many of our important seed-producing areas. Progress was being made in many areas after the disease was first found some six or seven years ago. It apparently reached a low ebb about three years ago, and has been on the increase since that time. No states gave a reason for this apparent loss of ground in the battle to control the disease. The writer's personal opinion is that after the original scare, six to eight years ago, strong efforts were being made by all agencies interested, to control the disease. Almost immediately, results were apparent. After two or there years, however, complacency set in, methods of control were released, and a disease build-up resulted. This more or less coincides with the beginning of our heavy war effort, also, and possibly lack of labor and other difficulties that beset the potato producer were equally, or even more responsible. The seriousness of the disease is clearly brought out in this survey.

The writer appreciates the excellent cooperation given by all states in submitting information. The identity of any particular state involved may be obtained by writing directly to Marx Koehnke, Nebraska Certified Potato Growers, Alliance, Nebraska.

NEW VARIETIES

H. O. Werner

During the early years of seed potato certification, much effort was devoted to standardization of varieties and the encouragement of the elimination of more than one or two varieties for commercial production in any community. This effort served a very useful purpose and eliminated much of the chaos that had existed in potato trading because of erroneous naming or because of varietal mixtures. However, as none of the old varieties possessed resistance to the most common and serious diseases and most of them lacked many desirable characteristics, the need of better varieties for practically every potato region became increasingly apparent as the years advanced.

Within the last 15 years approximately 25 new varieties of potatoes have been named and introduced in the United States by plant breeders. Several of these varieties are now grown commercially throughout widely separated parts of the country whereas others because of specific characteristics are grown extensively in certain localities. Within the next few years an even greater number of new varieties may be expected as a result of the extensive potato breeding projects of the U. S. Department of Agriculture and State Agricultural Experiment Stations.

The conference devoted some time to discussing the problems that will confront seed potato certification services in dealing with an increasing number of varieties. Although this discussion was by no means as extensive or exhaustive as the problems warrant—there seemed to be general agreement as to the desirability of the following procedures:

1. That any new variety should be properly described in some recognized publication such as an official bulletin or in the American Potato Journal and should thereafter be eligible for certification.

2. That it is frequently very desirable for the certification services to take an active part in the dissemination of seed stocks of new varieties. This is especially true with services that have a well-established foundation seed program.

3. That varieties should not be introduced until they have been tested extensively and been found to possess qualities that characterize them as being sufficiently superior to probably replace one or more present-day varieties, at least in certain localities or for certain specific purposes.

4. That introductory seed stocks be at least as free from seed borne diseases as certified seed and preferably as free as foundation seed stock.

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ERIE, A LATE POTATO ADAPTED TO OHIO

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Until recently, Russet Rural was the dominant late potato in Ohio. When well grown on porous soil it is of fairly good quality, but when the tops die prematurely, as often occurs either from poor soil or from insect damage, the tubers when cooked, turn dark. As the Russet Rural is readily distinguished on the market by its russet skin, consumers naturally turn to the white-skinned varieties. Ohio potato growers consequently have changed to the new white-skinned varieties as rapidly as seed becomes available.

At present, the dominant late potato in western Ohio is Katahdin, and in eastern Ohio, Sebago. Neither of these appreciably outyields Russet Rural and neither is distinctly superior in cooking quality, except in the important point that they do not discolor so badly when cooked.

A high-yielding seedling was selected in 1936 from a collection sent for testing by the United States Department of Agriculture to the Ohio Agricultural Experiment Station. It bore the number 47101 and was

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from a cross of Seedling 45146 by Earlaine. In six years of testing at Wooster, Ohio, it averaged 45 bushels per acre more than Russet Rural (table 1). In three cooking tests the color was consistently superior to that of Russet Rural, and the texture was judged superior in two tests and inferior in the third. By 1941 the seedling was deemed of sufficient value to name. The name "Erie" was chosen primarily to indicate that the variety was expected to be adapted to the region bordering on Lake Erie.

TABLE 1. *Comparison in yield and maturity of Erie and Russet Rural in small-scale tests in Ohio.*

Date planted	Erie		Russet Rural	
	Days to Mature	Yield per Acre[1]	Days to Mature	Yield per Acre[1]
On silt loam at Wooster:	Number	Bushels	Number	Bushels
1937, May 3	128	427	130	355
1938, May 20	120	260	123	244
1939, May 10	128	346	135	256
1941, May 13	130	165	130	206
1942, June 6	122	195	124	195
1943, May 28	130	304	133	172
Average	126	283	129	238
On gravelly loam in Columbiana County[2]				
1938	...	222	...	208
1939	...	189	...	182
1940	...	300	...	259
Average	...	237	...	216

[1]U. S. No. 1 tubers from duplicated 50-foot or longer rows.
[2]Tests conducted by Floyd Lower, County Agricultural Agent. In all seasons planted about June 1.

As early as 1939 seed stock was distributed in small amounts to a few certified seed growers supplying Ohio trade. The late Thomas B. Buell was keenly interested and by 1943 was able to supply commercial quantities. Some of his seed purchased by the Ohio Department of Public Welfare was grown at three localities in comparison with three

standard late varieties, certified seed being used throughout. In these field-scale comparisons Erie far outyielded the others (table 2).

TABLE 2. *Yields of Erie and three other varieties in field-scale tests conducted by Ohio State Department of Public Welfare,* 1943[1].

Location of Test	Yield per Acre of Usable Potatoes			
	Erie	Russet Rural	Katahdin	Sebago
	Bushels	Bushels	Bushels	Bushels
State Hospital, Toledo	306	212	201	210
Do , Apple Creek	443	227	156	322
Reformatory, Mansfield	401	160	133	236
Average	383	200	163	256

[1]Data assembled by J. D. Bragg, Agriculturist, Columbus, Ohio.

TABLE 3. *Yields of Erie and three other varieties at Muck Crops Experiment Farm, McGuffey, Ohio.*

Date Planted	Average Yield per Acre[1]			
	Erie	Katahdin	Sebago	Russet Rural
	Bushels	Bushels	Bushels	Bushels
1939, May 17	572	435	493	453
1940, May 14	315	393	297	346
1941, May 15	212	317	332	260
1942, May 12	671	595	638	610
Average	443	435	440	417

[1]50-foot rows, five replications.

On the other hand, on muck, which is the best soil for potatoes in Ohio, Erie has not been outstanding but has equaled three commercial varieties in a 4-year test (table 3). The tentative conclusion is that Erie is not inherently a specially high-yielding variety but rather has the

capacity to thrive better than other varieties under the unfavorable conditions commonly encountered on mineral soils in Ohio.

General Description

The plants of Erie growing in the field have the general appearance of the Green Mountain variety. Leaves and stems are light green, with no anthocyanin pigmentation. Flowers are white; anthers are slightly deformed; and pollen is mostly aborted—only about 2 per cent viable. The plants are highly susceptible to leafhoppers and flea beetles. The incidence of virus diseases in the stock at Wooster suggests that the plants have no resistance to these diseases. The time of maturity is medium late; as is shown in table 1, the plants die down 2 or 3 days earlier than Russet Rural.

The tubers are distinctly spherical, with moderately deep and fairly numerous eyes, and the skin is an attractive white. From incidental observations, it appears to be as susceptible to scab as any of the popular varieties. The tubers keep excellently in ordinary basement storage.

Erie can be recommended as a high-yielding attractive variety for commercial production in Ohio. The susceptibility of the plant to insects rules it out for the home gardener and small grower who are not equipped to spray.

Sources of Seed Stock

As is well known, mild symptoms of virus diseases are often masked by high summer temperatures, and this practically precludes the production of disease-free seed potatoes in Ohio. Several Ohio growers, enthusiastic about Erie, have attempted to maintain seed plots, but none of their stocks can be unreservedly recommended as foundation stock for others. The Ohio Experiment Station likewise maintains a seed plat to supply interested growers and other stations, but this stock also has some virus infection and should be grown in tuber units if it is to be increased for seed purposes. The limited quantity of seed grown in Michigan appears to be the best stock at present.

PLACEMENT OF FERTILIZERS FOR POTATOES[1]

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For many years, it has been generally accepted that the best placement of fertilizers for potatoes was in two bands, two or three inches from, and slightly below, the level of the seed piece. More recently, "plow-sole" applications have given good results with some crops, particularly corn in the middle west. The possibility that our heavily fertilized potatoes might also benefit from such uncommonly deep placements, was the justification for some tests at the Storrs Experiment Station in 1944.

The tests were located on the Vegetable-Agronomy Farm at North Coventry. The soil is Merrimac fine sandy loam, a water formed soil, underlaid with gravel about 18 inches below the surface. The land used in 1944 had grown heavily fertilized potatoes in 1937, 1939, 1940 and 1943, and unfertilized green manure crops in 1938, 1941 and 1942. Although the field is nearly level, slight variations in elevation have important effects on the moisture in the soil and on the ability of potatoes to secure adequate moisture during dry periods. For this reason, particularly, the experiment was planned so that all comparisons of placements with the same *total* amounts of fertilizers could be made between plots adjacent to each other on the long dimension. Each of the nine plow-sole treatments appeared on three 75 x 18 foot plots, each replicate being represented in each of the three series.

The plow-sole fertilizers were weighed for each furrow and applied by hand as the plots were being plowed in late April. On the 3d of May, the plots were planted with Green Mountain potatoes by a two-row, assisted-feed planter, calibrated to apply the desired amounts of machine added fertilizer. To open furrows for additional, hand-applied fertilizer, auxiliary disks were attached behind the covering disks of the planter. The amount of fertilizer for each side of each row was weighed and sown by hand in those furrows. This hand-applied fertilizer was covered by harrowing down the ridges left by the covering disks. Its location was slightly above and farther from the seed pieces than the fertilizer added by the planter.

In many experiments on this and other soils in Connecticut, it had been found that maximum yields of potatoes were obtained with about 100 pounds of nitrogen, 160 pounds of phosphoric acid (less under continuous culture), and 120 to 140 pounds of potash per acre. In the

[1]Contribution from the Department of Agronomy, Storrs (Connecticut) Agricultural Experiment Station.

[2]Associate Agronomist.

1944 "placement" experiment, the one hundred per cent application consisted of 100 pounds of nitrogen, 160 pounds of phosphoric acid, and 160 pounds of potash. The carriers used to obtain those plant nutrients were sulphate of ammonia, 47 per cent superphosphate, and 60 per cent muriate of potash. The following outline gives the different placements included in the experiment:

Placements of potato fertilizers tested in 1944

	On Plow-Sole (Band in Each 14" Furrow)	By Planter (Two Bands per Row)	By Hand after Planting (Two Bands per Row)
I.	(a) 50 per cent P	50 per cent (NPK)	50 per cent (NK)
	(b) 50 per cent (PK)	50 per cent (NPK)	50 per cent N
	(c) 50 per cent (NPK)	50 per cent (NPK)	None
II.	None	100 per cent (NPK)	None
III.	(a) 100 per cent P	None	100 per cent (NK)
	(b) 100 per cent (PK)	None	100 per cent N
	(c) 100 per cent (NPK)	None	None
IV.	None	150 per cent (NPK)	None
V.	(a) 100 per cent P	50 per cent (NPK)	100 per cent (NK)
	(b) 100 per cent (PK)	50 per cent (NPK)	100 per cent N
	(c) 100 per cent (NPK)	50 per cent (NPK)	None

TABLE 1—*Plow-sole application of fertilizers for potatoes.*

In spite of a freeze on the 19th of May, good stands of potatoes were obtained on all plots. There were a few more missing hills where the 100 or 150 per cent rates of fertilizer were applied with the planter, particularly in the second series, which had drier soil than the first and third series. One month after planting, the potatoes had made the same growth on all plots, with the exception of those with *all* of the phosphorus (superphosphate) on the plow-sole. The latter were less than half as large as the others and showed the characteristic spindly appearance due to phosphorus deficiency. When all the phosphorus was on the plow-sole it made little difference where the nitrogen and potash were placed. As the season progressed, these differences in size of plants gradually decreased but, on account of the extremely dry weather, another appeared. Because of the slower development of the phosphorus-deficient potatoes, they required less water in mid-summer and consequently remained green somewhat longer than those receiving at least a part of the phosphorus in bands near the seed pieces. On all plots, however, the vines were dead at an unusually early date (August 15).

TABLE 1—*Plow-sole application of fertilizers for potatoes.*

Treatment No.	Fertilizer Placements[1]			Relative Growth June 8[2]	Per Cent Stand June 8[3]	Average Yields of Triplicate Plots	
	On Plow-sole by Hand	In 2 Bands by Planter	In 2 Bands by Hand			Total Bushels Per Acre	As Per cent of Adjacent Checks[4]
1	50 per cent P	50 per cent (NPK)	50 per cent (NK)	104	81	262	105
2	50 per cent (PK)	50 per cent (NPK)	50 per cent N	101	80	265	106
3	50 per cent (NPK)	50 per cent (NPK)	None	103	83	241	110
	Averages of Treatments 1, 2 and 3			103	81	256	107
4	100 per cent P	None	100 per cent (NK)	48	77	214	90
5	100 per cent (PK)	None	100 per cent N	32	83	199	85
6	100 per cent (NPK)	None	None	42	84	219	93
	Averages of Treatments 4, 5 and 6			41	81	211	89
7	100 per cent P	50 per cent (NPK)	100 per cent (NK)	96	79	246	90
8	100 per cent (PK)	50 per cent (NPK)	100 per cent N	99	79	222	86
9	100 per cent (NPK)	50 per cent (NPK)	None	114	77	232	92
	Averages of Treatments 7, 8 and 9			103	78	233	89

[1]100 per cent "N" equals 100 pounds of nitrogen (N) per acre from sulphate of ammonia; 100 per cent "P" equals 160 pounds of phosphoric acid (P_2O_5) from 47 per cent superphosphate; and 100 per cent "K" equals 160 pounds of potash (K_2O) from 60 per cent muriate of potash. The fertilizers were weighed for, and applied on the plow-sole of each furrow as the plots were being plowed between the 22nd and 27th of April. A modern two-row planter, calibrated just before planting on the 3d of May, was used to add the planter-distributed fertilizers; the "in bands by hand" fertilizer was weighed for each side of each row and sown by hand on the 11th of May in a narrow furrow opened by auxiliary disks attached behind the covering disks of the planter and was covered the same day by harrowing down the ridges.

[2]Relative to adjacent plots receiving the same total amounts of fertilizer entirely applied by the planter.

[3]Planter was set to drop seed pieces one foot apart and the "per cent stands" in this column are the actual number of plants per 100 feet of row. On the same basis, the nine plots with the 100 per cent (NPK) by planter averaged 79 per cent, and the nine plots with 150 per cent (NPK) by planter averaged 74 per cent.

[4]The "adjacent checks" received the same *total* amounts of fertilizer as the plots with which they are compared, but all of it was applied in two bands by the planter.

A summary of the results is given in table 1. The data appear to justify two statements: (1) Placing all of the phosphorus on the plow-sole greatly retarded the early growth of the plants and consistently reduced the yield of tubers by approximately 10 per cent. (2) None of the nine plow-sole placements resulted in significantly better stands, growth or yields than the same amount of fertilizer applied in two bands by the planter.

Although the results in 1944 were not favorable to plow-sole application of fertilizers for potatoes, it is planned to conduct further and somewhat different tests in 1945.

POTATO BREEDING, GENETICS, AND CYTOLOGY: REVIEW OF RECENT LITERATURE[1]

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A few years ago the literature on potato breeding, genetics, and cytology was not very extensive, and as a result potato breeding was more of an art than a science. In recent years the interest in these subjects has increased very rapidly, and judging by the large number of articles that are now being published potato breeding is rapidly becoming a science.

In this report articles are reviewed covering the following subjects:

(1) Research in potato breeding.
(2) Tuber and floral development in relation to length of day.
(3) Pollination techniques.
(4) Self-incompatability.
(5) Cytology.
(6) Seed germination and viability of potato seeds.
(7) Dry matter and starch content.
(8) Dehydration.
(9) Resistance to viruses.
(10) Late blight investigations.
(11) Scab tests.
(12) New varieties.

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[1]Some of the material in this report, especially that concerning articles written in foreign languages, was taken from the abstracts published by the Imperial Bureau of Plant Genetics, Cambridge, England.

[2]Senior Geneticist.

(13) Breeding material.
(14) Resistance. to nematodes.
(15) The Buba disease.

Research in Potato Breeding

Salaman (32) reporting on recent research in potato breeding stated that a new era in potato breeding in England dates from the recognition of the existence of wart disease in scattered localities and from the discovery of immune varieties in 1908 by G. C. Gough. Little progress was made to combat the new danger until the pressure of war was felt in 1915. The importance of the potato as a foodstuff was then vividly brought home to a public hitherto accustomed to regard the entire world as its larder.

Many synonyms were discovered among the varietal names. For example, the variety Up-to-Date was known and grown under 200 names. Salaman (32) states that Salaman and Lesley showed that resistance to the wart disease is controlled by genes acting on relatively simple Mendelian principles. Research on resistance to viruses was undertaken in Great Britain in 1920. The Potato Virus Research Station, under the directorship of Salaman, was established at Cambridge in 1926. Other subjects discussed in the article are virus-resistant varieties; the influence of recent Russian discoveries on variety production; mutability of potato tubers; new sources for the creation of specialized varieties; blight-resistant varieties; past experiences and future promises; and a summary of materials available with the particular characters that may be used in potato breeding. A total of seventy-two articles was cited.

Influence of Length of Day

Driver and Hawkes (13) investigated the reactions to length of day of a collection of Peruvian potatoes and one wild Mexican species, *Solanum demissum*. They concluded that potatoes differ in their response to day length. Some South American species refuse to form any tubers under long-day conditions, but others form them equally well under a range of photoperiod and may even prefer long days. The early varieties of high latitudes would seem to approach more nearly the true long-day type, whereas the late varieties are possibly an intermediate type giving higher yields in the higher latitudes, largely because of the greater vegetative growth during the long warm days of summer. Maturity is hastened by short days at normal temperatures, but under low temperatures the reverse may be true. The optimum air temperature for tuber growth seems to lie between 60° and 65° F.,

tuberization decreasing rapidly as the temperature rises above 70°, with a maximum temperature of 80° to 85° F. for tuber formation. The failure of plants to produce tubers or the very low yields obtained in the tropics may be due largely to the high temperature prevailing during the growing season.

The type of stolon development separated the species tested into four main groups:

1. Short stolons in short day; none in long day.
2. Short stolons in both short and long day.
3. Short stolons in short day; long stolons in long day.
4. Long stolons in both short and long days.

The results for growth and maturity indicate that the clones under consideration take, on the average, about one and a half times as long to mature under long day as under short day. The height of plants, however, is about two and a half times as great. Few well-marked interspecific differences were noted in these reactions. Short days were shown to exert a depressing influence on flowering, though it is pointed out that flowering is extremely abundant in the high Andes under short-day conditions. To explain this apparent contradiction it was suggested that flowering is more dependent on the quantity of light received than on the length of day. A 12-hour day of the intense light of tropical mountains is sufficient to induce flowering, but it requires a summer day of 15 to 18 hours to induce flowering in temperate regions.

Pollination Techniques

Henderson and LeClerg (19) found that in Louisiana the prevalence of non-fruitfulness in potato varieties due to pollen sterility and premature abscission of flowers substantiates generally the reports of other workers in different regions. The data do show, however, that an encouraging number of fruitful varieties and seedling varieties possessing superior germ plasm are available to the plant breeder. During the seasons 1940 and 1941, the covering of potato flowers with kraft-paper or cheese-cloth bags was detrimental.

In view of the results it seems advisable to emasculate and bag potato flowers one day and apply pollen on the following day. For best results the pollination work should be done during a period in which relatively low temperatures and adequate soil moisture conditions normally prevail.

Black (4) outlined a method of producing fertile blight-resistant hybrids between *Solanum demissum* (2n = 72) and *S. tuberosum*

(2n = 48) involving the use of a "bridge" species *S. rybinii* (2n = 24). A cross was made between *S. rybinii* and *S. demissum*. From this cross one seedling was produced with 48 somatic chromosomes. This plant was crossed with *S. tuberosum*, the triple hybrids thus produced being perfectly fertile.

The common strain of blight (A) and a more virulent form (B) were tested on several generations of the above-mentioned hybrids, as well as on the ordinary cross *S. demissum* X *S. tuberosum*. The data obtained lead the author to suggest that the resistance to the two blight strains is controlled by two genes of different phylogenetic origins, which he names *Ra* and *Rb*. *Ra* confers resistance to the A strain and *Rb* to both strains. An increased concentration of *Ra* genes does not however confer resistance to the B strain of blight.

In the author's opinion the results obtained agree with the theory that the basic chromosome number in *Solanum* is six. On this hypotheses *S. rybinii* would be allotetraploid, *S. tuberosum* an allo-octoploid, and *S. demissum* an allododecaploid.

Self-Incompatability

Filippov (17) described methods of overcoming cross-incompatability in potatoes. Young seedlings of *Solanum acaule* were grafted on different varieties of *S. tuberosum*. From 1,000 flowers of the *S. acaule* scion, pollinated with pollen from a number of different domestic varieties, 41 berries with seeds were obtained. The flowers had been bagged but not emasculated. The F_1 seedlings were all very much like the cultivated type but displayed certain features of *S. acaule*, including low growth habit, long stolons, and frost resistance. One of the most frost-resistant and high-yielding seedlings was back-crossed onto Fürstenkrone, giving rise to 136 seedlings. Some of the resulting seedlings were self-fruitful. Some remained undamaged by -3°C to -3.5°C.

Pal and Puskar (29) reported that the diploid (2n = 24) species *Solanum aracc-papa, S. caldasii, S. chacoense, S. jamesii,* and *S. subtilius* are characterized by a high degree of physiological self-incompatability, whereas several tetraploid (2n = 48) species and the hexaploid (2n = 72) species *S. demissum* are self-compatible. The genetics of self-incompatability was studied in 16 varieties of *S. caladasii* and one variety of *S. subtilius*. In families derived from crosses involving these varieties, at least 5 sterility factors (S_1 to S_5) were found, and they behaved as oppositional factors. Other results suggest that *S. chacoense* possesses a fertility factor *F* in addition to the *S* factors. It is

also suggested that there appears to be no foundation for regarding *S. caladasii* and *S. subtilius* as separate species.

Carson and Howard (9) reported that both *S. rybinii* and the closely related species *S. boyacense* (clone E P C 546) set no berries on selfing. Berries with numerous seeds are obtained on crossing the two species in either direction, and both species are cross-compatible with their F_1 hybrids. The hybrids produce no berries on selfing. It is also suggested that two other diploid ($2n = 24$) species, *S. phureja* and *S. lanciforme*, are self-incompatible.

Cytology of the Potato

Cadman (6) reported on the nature of tetraploidy in cultivated European potatoes. He said that the family Solanaceae to which the potato belongs appears to be characteristically polyploid with the basic number 12, $2n = 24$ being the lowest chromosome number actually found. The European-cultivated potatoes with 48 somatic chromosomes might therefore be suspected of being tetraploids.

Although quadrivalents have been seen by Stow, Meurman, and Rancken and by Ellison there is no precise information on the frequency of their occurrence. In the genetic literature, on the other hand, two opposing views are to be found. The earlier workers, for example Salaman, and more recently Black and Collins regarded the plants as functional diploids. The genetical possibilities of tetraploidy, though perhaps appreciated by K. O. Muller in 1930 and by Asseyeva and Nikolaeva in 1935, were not fully considered until 1937, a decade after the publication of the initial cytological facts just outlined. To this situation must be added the further complication of speculations on the true basic number of the solanaceous polyploid series. Assuming this to be 6 and not 12, allo-octoploidy has been proposed, though not as yet employed, as a working hypotheses for potato genetics.

The choice essentially lies between a disomic and a tetrasomic interpretation of inheritance in this plant. Data which would critically distinguish between these two alternatives are not yet fully adequate for the purpose.

Lamm (23) reported that unlike *Solanum tuberosum* ($2n = 48$), in which quadrivalents, trivalents, and univalents are formed besides bivalents, the chromosomes of *S. punae* ($2n = 48$) form 24 bivalents at meiosis. Octoploid plants produced by colchicine treatment of this species showed remarkable vigor and fertility, unlike artificially produced octoploid *S. tuberosum*. At meiosis the greater part of the chromosomes formed bivalents. About 7 quadrivalents and a few trivalents and univalents were also formed.

On the basis of its chromosome behavior, *Solanum punae* is considered an allotetraploid and *S. tuberosum* an autotetraploid. Crosses between octoploid and *S. punae* and tetraploid *S. tuberosum* are recommended for the production of frost-resistant potatoes.

Seed Germination and Viability of Potato Seeds

Clarke and Stevenson (10) reported on the factors affecting the germination of potato seeds. The percentage and velocity of germination were more satisfactory when seeds were planted not more than one-eighth inch deep. No significant differences were obtained by covering the seeds with soil, with 50 per cent soil and 50 per cent sand, or with sand. High temperatures, 25° C. day and night, reduced the percentage and velocity of germination. Alternating the temperature between 20° and 30° was more satisfactory than maintaining a constant temperature of 25°. A higher velocity of germination was obtained when the seeds and seed-ball debris were allowed to ferment before washing and drying. Soaking the seed in an aqueous solution of potassium nitrate did not affect the percentage or the rate of germination.

Wollenweber (37) gave a report on the longevity of potato seeds. Seeds were harvested in 1922 from naturally fertilized fruits of the variety Deodava and kept in class bottles at room temperature. In March, 1935, the seeds tested were all viable; 5 years later, 26 per cent germinated; and 2 years later (*i.e.*, after 20 years) 17 per cent germinated. Seed from the variety Thieles Früheste gave 9 per cent germination in the twentieth year.

Dry Matter and Starch Content

Akeley and Stevenson (1) reported transgressive inheritance resulting in hybrid vigor in a cross between Chippewa and Katahdin. In the Maine variety tests from 1939 to 1942 Sequoia outyielded Green Mountain significantly. Pontiac, Earlaine 2, and Mohawk were in the same class as Green Mountain. Among the early varieties Irish Cobbler, Warba, and Red Warba were similar in yields. Ackersegen was the highest yielder of the European varieties, and over a 2-year period was comparable to Katahdin in the production of U. S. No. 1 tubers. Genetic segregation for dry-matter content of the tubers was evident when the comparisons of sibs were made within three family lines. Environmental conditions affected this character to a high degree, a variety grown in one location differing very greatly from the same variety grown in another place. A few European varieties were higher in percentage of starch content than the American varieties that were tested, but in the calculated production of starch per acre when total yields per acre were

taken into consideration several American varieties outyielded all but one of the European varieties. This foreign variety, Ackersegen, is very unsatisfactory in other characters. It has yellow flesh, gives a low yield of U. S. No. 1 tubers per acre, is too late in maturing for conditions in the United States, and has low market quality.

Akeley and Stevenson (2) reported a continuation of the study of the inheritance of dry-matter content in potatoes. Five parents were selected and used because of the wide differences among them in dry-matter content. In 1943 tuber density ratings were obtained for five clones, four selfed lines, and eight crosses. The latter represented various combinations of dry-mater content as follows: High x high, high x medium, high x low, and medium x low. The cross with two high-density parents gave the highest mean density for its progeny. This was followed in order by high x medium, high x low, and medium x low. Only a few seedlings in the latter combination would likely be high enough in dry-matter content for commercial purposes. High tuber density seemed to be dominant to low.

Prokosev and Kameraz (30) reported the results of analyses that were made on the 1935 crop of a large number of hybrids of wild potato species with *Solanum tuberosum*. Many of the wild and primitive cultivated species have tubers with exceptionally high dry-matter content, and the F_1 hybrids of such species as *S. demissum* and *S. antipoviczii* also have high dry-matter content. The same applies to many of the backcrosses. In crude protein content these hybrids are generally intermediate between the two parents and often approach the lower of the two. They are generally intermediate between the parents in starch content. Some of the hybrids from such species as *Solanum demissum* and *S. molinae* give very high values. The first-generation hybrids with wild forms are generally of very low quality, but their backcrosses with *Solanum tuberosum* may in certain combinations have rather high starch content.

Dehydration

Caldwell *et al.* (7) reported the results of a study of the suitability for dehydration of early-crop white potatoes and of the comparative quality of the dehydrated product made from the principal varieties grown in the chief early-crop districts. The factors studied were: variety, place of production, and stage of maturity at time of harvest. As a whole, the dehydrated products made from early-crop potatoes ranked significantly lower in quality and in general desirability than those made by identical methods from late-or main-crop potatoes of the same varieties. This result is due in considerable part to the cus-

tom of harvesting when the plants are still green and vigorous and the tubers immature. It may be due in part to imperfect adaptation of existing varieties to the climatic conditions under which the early crop develops and matures.

Caldwell *et al.* (8) studied 20 varieties of potatoes from various late- or main-crop potato-producing states to determine their suitability for dehydration. The samples were obtained from the states of Washington, Idaho, Colorado, Pennsylvania, and Maine, and from two locations each in Michigan and New York. No particular district showed any consistent or general superiority in dehydration quality of the potatoes there grown. No single variety showed outstanding superiority in quality of product. Of the 20 varieties studied, 19 rated excellent in one or more districts but were rated very good to fair in others. All the varieties tested are potentially capable of producing material of high quality, provided they are grown under conditions to which they are well adapted, but are of lower quality for dehydration when grown under conditions to which they are not adapted. Correlations between dry matter of the tubers as shown by their specific gravity and quality of the dry product were observed.

Resistance to Viruses

Stevenson *et al.* (34) stated that leaf roll has become a serious menace in some of the best potato-growing sections of the United States. In varieties such as Katahdin, Chippewa, and Sebago the losses are due to reduction in yield resulting from the rolling and yellowing of the leaves and the dwarfing of the plants. In varieties such as Green Mountain the development of net necrosis in the tubers causes additional losses. One European variety, Triumf, showed some resistance. Fifty-four South American varieties planted in the exposure test in 1936 showed some leaf roll in 1937. During 5 years (1938-42) 55 progenies consisting of 5,518 seedlings were tested at Highmoor Farm, Monmouth, Maine. Three hundred of these showed no leaf roll in 1942.

Le Clerg *et al.* (25) reported the results of experiments made during the period 1939 to 1942, inclusive, to determine the effect of different amounts of spindle tuber and leaf roll on yield of marketable tubers in several varieties of Irish potatoes in seven states. The trend was generally for a progressive decrease in yield as the amount of either disease increased. The reduction in yield at the 4 and 8 per cent levels of spindle tuber or leaf roll infection is relatively small from the standpoint of the commercial grower. Katahdin, Irish Cobbler, and Green Mountain were similarly affected by spindle tuber. The reduction in yield due to 100 per cent leaf roll infection was greater with Irish Cob-

bler in Maine and in Virginia in 1940 and 1942 than it was in New Jersey. This disease was more serious with Katahdin in Florida and Maine than in Louisiana. During 1940 to 1942, inclusive, the percentage reduction in yield of Katahdin in Florida, Louisiana, and Maine caused by 100 per cent leaf roll was markedly and significantly greater than that resulting from 100 per cent spindle tuber.

Le Clerg (24) described a non-virus leaf roll which is probably a heritable character. Varietal differences in the frequency of the disease were reported.

Rieman and McFarlane (31) reported that the Sebago variety of potato exhibited a high degree of field resistance to the yellow dwarf virus and that this character was inherited in the progeny of the cross Sebago X Hindenburg.

Dufrénoy (14) reported on the resistance to X+Y virus in hybrids of Katahdin. This variety and others such as Chippewa, Sebago, and Seedling 41956 are being used in breeding work in France by members of the Centre Nationale de la Recherche Scientifique.

Cockerham and Cadman (11) reported a systematic examination of old and new cultivated varieties, promising seedlings, and South American forms of potato for their reactions to individual potato viruses. Suspected new viruses were found in the South American forms. Each of these has been transmitted by graft and sap inoculation, but no transmission by the aphis *Myzus persicae* has been confirmed. One new virus seems to be closely related to virus Y; another one is closely related to virus X, or is invariably associated with it. Seedling varieties resistant to leaf roll in the field have been submitted to infection through graft unions and to infestation with infective aphids. Many seedlings were found susceptible under the more stringent tests, but some emerged from all tests in symptom-free condition.

Late Blight Investgations

Black (5) reported that the potato-breeding work of the Boghall Substation is directed mainly towards producing improved varieties by incorporating, as far as possible, blight resistance with field immunity from viruses A and X, and resistance to leaf roll with other desirable qualities possessed by the best cultivated varieties. During 1943 over 8,000 new seedlings obtained from 24 hybridizations were raised and tested for resistance to late blight. All the parental combinations contained the late-blight-resistent character, most of them contained field immunity from viruses A and X, and a substantial number contained resistance to leaf roll. The breeding of seedlings combining resistance to blight and field immunity to viruses A and X presents no unusual diffi-

culties, as these characters are inherited in a dominant manner. The other characters, however, desired in a new variety are many, and practically all of them are obtainable in a heterozygous condition. Large numbers of seedlings must be grown so that the full range of combinations may have a chance to appear. Progress must necessarily be slow until it is possible to handle the requisite size of progenies. In the routine tests for blight resistance the common strain of the pathogen prevalent among cultivated varieties was used. Other strains have somewhat complicated the problem.

In this work *Solanum polyadenium*, which is blight-immune and is very repulsive to green flies, showed greater disease-resistant properties than any other potato species. Numerous attempts to cross it with other species and varieties have failed except in one instance in 1937 when it was successfully crossed with a species-hybrid plant. Since then cultivated varieties and other species have been introduced into the pedigree, but fertility has been low and the characteristics of the seedlings have been mainly those of the wild type. In 1943 at the Midland Agricultural College, Loughborough, several seedling varieties immune from the common strain of blight gave promising results in comparison with standard varieties.

Further additions were made to the collection of Mexican and South American potatoes maintained at Boghall. The investigations concerning the economic potentialities of the collection, the intercompatibility of the species, the genetics of certain characters, and the cytology of species and species hybrids were continued.

Vinogradova (36) gave a rather interesting report on methods of breeding potatoes for blight resistance. A full account is given of the biology of the fungus *Phytophthora infestans*. All cultures of the parasite raised on leaves of a resistant variety 8670 proved more virulent than ordinary cultures. When the former were reproduced on tubers, however, they lost their virulence. These forms were considered as modifications rather than as distinct races. The influence of manuring and other external factors on resistance was discussed. Evidence as to how far resistance is affected by the age of the plant was inconclusive. In general, it is concluded that any combination of factors that produces a strong healthy plant also promotes resistance. Leaf and tuber resistance are not always correlated, and leaf resistance is regarded as of more practical importance than tuber resistance.

In breeding for *Phytophthora* resistance the seedlings in the early stages were tested by the leaflet method, and observations were also made in the field. All field-susceptible seedlings were discarded, and the

selected seedlings were tested in later years by artificially infecting whole plants in the greenhouse. No agreement was observed, however, between seedling reaction and the reaction of the mature plant. No artificial test can, it is thought, entirely take the place of field observations, and it is desirable to grow all promising seedlings as soon as possible in infected fields in various localities to test their behavior under natural conditions.

Müller and Börger (28) described in detail the results of testing the so-called W varieties of potatoes with two strains of *Phytophthora infestans*. When the W varieties were inoculated with strain A to which they are resistant and 24 hours later with strain S_3 to which they are normally susceptible no infection took place, though occasional hyphae penetrated and would sometimes produce a mycelium when the inoculated end of the tuber was removed. No reduction in infection was observed when cut tubers were left for 24 hours without inoculation with strain A and then inoculated with strain S. The S-immunity acquired after infection with A was confined to the necrotic areas produced by the A infection, or to the tissues immediately adjacent to them; and the actual extent of the immunized area was proportional to the degree of resistance of the variety. Simultaneous application of strains A and S caused a certain inhibition of S but to a less pronounced degree than when S was applied 24 hours later. The immunizing effect of strain A was found to be proportionate to its relative concentration though no concentration of A was sufficient to prevent infection with S if both are applied together.

Cultures taken from sporangia developing from a mixed infection with races A and S on a W variety consisted exclusively of strain S. Those from a similar infection of a susceptible variety (Frühegold) consisted of equal proportions of both strains. Though the parasite was inhibited by pretreatment with strain A, it remained viable for at least 9 to 10 days and could produce necrosis when a small piece of the infected tuber was grafted on a tuber of a susceptible variety. A preliminary inoculation with strain A of *P. infestans* made the tubers also resistant to attack by *Fusarium coeruleum*, showing that the effect is not "strictly specific." The growth even of the saprophytic organisms, such as *Fusarium solani* and *Penicillium glaucum*, was also inhibited. The results are discussed and compared with those of other workers in a critical review of the literature on acquired immunity in plants. The difference between the resistant and susceptible varieties is that the former react more rapidly and their cells die sooner under the influence of the parasite. The S strain of the parasite is actually less virulent than

the A strain so that the W cells react less violently and a certain degree of symbiosis is established leading to infection. Infection with strain A leads to the liberation of a toxic substance which then confers immunity to strain S. This substance or group of substances is thought to be allied to the tannins.

Meyer (*27*) described the development of the mycelium of *Phytophthora infestans* strains of group A on cut tubers of blight-susceptible cultivated varieties and on the W races of potatoes. The W races, which are all resistant in the leaf, differed in tuber resistance. No fructations were observed in the resistant forms, and tannin-detecting reagents gave a positive reaction at an earlier stage than in the susceptible tubers.

De Bruyn (12) described experiments which gave evidence that *Phytophthora infestans* can live saprophytically. It grows best on partially decayed plants. In nearly all soils, therefore, organic parts upon which the fungus can feed will be present. In addition to the presence of suitable food, moisture and temperature must be taken into account. Moisture is necessary for the good development of the fungus and is an important factor in connection with renewed growth in the spring and with the first foliage infection. The fungus can, however, withstand cold as well as drought. The oospores and the resting forms are the resistant organs, and both are probably produced in nature. They are able to live more easily in a dry than in a moist condition, and to endure a temperature of —20° to —26° C. for 5 days.

Phytophthora infestans can remain alive outside the potato plant. Its growth on the whole is rather slow and is abundant only in the presence of moisture. However, the fungus is not easily killed. If *P. infestans* finds the right conditions for overwintering on only one-thousandth part of the field this will be enough to produce a blight epidemic the following year.

Scab Tests

Stevenson *et al.* (35) reported the results of testing 22 varieties of potatoes for resistance to scab (*Actinomyces scabies*) in four widely distant localities. In general, the varietal reactions were quite constant for the 2 years and the four places. The highly resistant varieties showed less tendency to vary between years or between places than the slightly resistant or susceptible ones. The interactions between variety and place were significant and could be due to environmental factors or to physiologic strains of the organism, or to both.

New Varieties

The Pawnee potato described by Edmundson and Schaal (15) was a selection from the cross Rural New Yorker No. 2 and Katahdin. It is believed to be a valuable medium-early variety for certain potato-growing districts. The general adaptation of this variety is not yet known. It is very promising for both the early and the late crop in the Greeley, Colorado district, where it produces good crops of attractive smooth tubers that are uniform in size and have shalllow eyes and relatively tough skin. Preliminary tests indicate that it will be valuable in other states.

Jenkins (20) concluded from results of yield trials at three different stations in South Carolina that Irish Cobbler and Katahdin are the best white-skinned varieties for that region, though Chippewa may produce good yields. Pontiac, a red-skinned variety, was the highest yielder, but it was inferior in some ways to the Triumph.

Stevenson (33) gave a brief summary of the methods, accomplishments, and future prospects of the work of the National Potato-Breeding Program. Seventeen new varieties have been distributed to growers. In 1943 thirteen of these were found in the certified seed potato lists representing about 29 per cent of all the certified seed grown in the United States. Many characters of vital importance have been brought to light, and though it will take a relatively long time to combine all these in one variety, real progress has been made toward that end.

In 1942 the Mohawk variety, as pointed out by Hardenburg and Stevenson (18), was named and introduced jointly by the Department of Vegetable Crops of the Cornell University Agricultural Experiment Station and the United States Department of Agriculture. It originated in Maine from a cross between Green Mountain and Katahdin. Since 1935 it has been tested for yield and quality under various sets of environmental conditions. Results have been promising in New York, especially in sections favorable for Green Mountain and Houma. Mohawk combines the high market quality of Katahdin with the high baking quality of Green Mountain. It produces high yields of mealy fleshed, regularly shaped, somewhat elongated tubers. It is resistant to mild mosaic and moderately resistant to tip burn, flea beetle injury, and hopperburn. It is offered to the trade in New York state as a high quality baking variety.

The Kasota variety described by Krantz *et al.* (22) appears to be well adapted to locations favorable to a midseason variety. In Minnesota it has offered the most promise in the Red River Valley. It has grown well in westen Nebraska with irrigation. It is very heat-tolerant, and

the plants survive drought better than Triumph and most other varieties. Kasota was tested for 6 years in a field heavily inoculated with *Fusarium solani v. eumartii* in Nebraska, and in 5 of the 6 years only one-third as many of its tubers have shown stem end rot and vascular discoloration as of Triumph and Cobbler. The results were inconclusive one year due to a slight yellowing and darkening of the vascular system that was not easily distinguished from *Fusarium* infection.

Breeding Material

Kameraz (21) in Russia reported variation in the wild species in respect to such characters as habit, pigmentation, length of stolons, number of tubers per plant, size of tubers and their form and color, earliness, period of dormancy, time of flowering, and length-of-day reaction. Data are given on dry-matter, nitrogen, and starch content. *Solanum semidemissum* showed the highest protein content (4.56-6.82%). Starch content up to 26 per cent was found in some of the wild species. Some of these have unusually large starch grains. Vitamin C was exceptionally high in *S. Antipoviczii v. Gandarae densipilosum*. Resistance to *Phytophthora* was found only in Mexican species with the exception of *S. Vavilovii*, which showed no infection under natural conditions. A few of the wild species were tested for wart resistance with contradictory results. Almost all tuberiferous species suffer with "degeneration" when grown near Leningrad, though some suffer less than others. Several species were immune to Colorado beetle and a number were resistant to varying degrees of frost.

Maximovic (26) reported that the great hopes attached to the use of the South American potatoes in breeding work in the U. S. S. R. have not been fully justified. One blight-resistant variety has been produced, but it is inferior in quality to varieties such as Lorch. Effects of environment in inducing mutations are emphasized. Data are given to show the great increase in yield given by plants grown from tubers obtained from summer plantings, compared with those from spring plantings. A yield increase varying from 20 to 70 per cent was obtained from tubers of the variety Lorch produced under conditions of high farming. Such plants were also more disease-resistant. One seedling produced dark blue tubers when grown in peaty soil and white tubers when grown in sandy soil. Vegetative hybridization as a method of inducing mutations is also emphasized. The variety Fürstenkrone grafted into Wohltmann caused the latter to produce white tubers altered in form, and this alteration persisted when they were reproduced. Date of maturity and yielding ability have also been changed by grafting.

Resistance to Nematodes

Ext and Goffart (16) reported their findings on nematode resistance of potatoes. No immune varieties were found. Most varieties show considerable variation in the amount of attack, and the extent of cyst infestation bears no direct relation to the plant growth. Many early varieties showed considerable damage from slight infestation. Several late varieties in spite of considerable infestation exhibited only slight signs of damage. Even if varieties of the latter type, such as Ackersegen and Voran, give good yields, in some cases this may be because in late varieties tuber growth does not begin until after the nematodes have attained maturity. The yields of such nematode-tolerant varieties, however, tend to decline rapidly, and cultural measures must be used to defeat the pest.

The Buba Disease

Barrus and Muller (3) reported the appearance of a new potota disease in Venezuela. This disease, known locally as "Buba," was found affecting about 10 per cent of the tubers of native potato varieties at high altitudes in the State of Merida, Venezuela. It also occurs in Ecuador and Peru. Diseased tubers are malformed, and the numerous brownish-black specks occurring throughout the flesh proved to be cavities filled with yellowish-brown sporeballs, each containing 2 to 8 cells. Attempts to germinate spores failed, and until this can be accomplished the taxonomic position of the fungus remains uncertain. Bliss Triumph potato seed-pieces planted in infected soil in pots produced tubers exhibiting evidence of infection. Uninfested soil produced healthy plants.

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REPORT OF THE TREASURER

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Miscellaneous	88.39	73.78	212.77	185.19
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Printing and Mailing of Journal	*1$1841.46	*2$1819.55	*3$2618.75	*4$2385.86
Reprints	183.10	193.65	331.88	266.63
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Miscellaneous	38.99	22.20	62.98	84.64
Secretarial Work	200.00	.....	.....	100.00
Stenographic Service	227.40	92.80	115.00	150.00
TOTAL EXPENDITURES	$2725.03	$2301.41	$3296.94	$3216.48
BANK BALANCE	$ 10.98	$ 54.78	$ 133.54	$ 417.99

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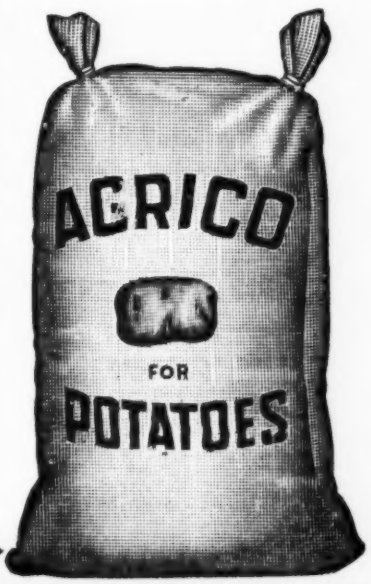

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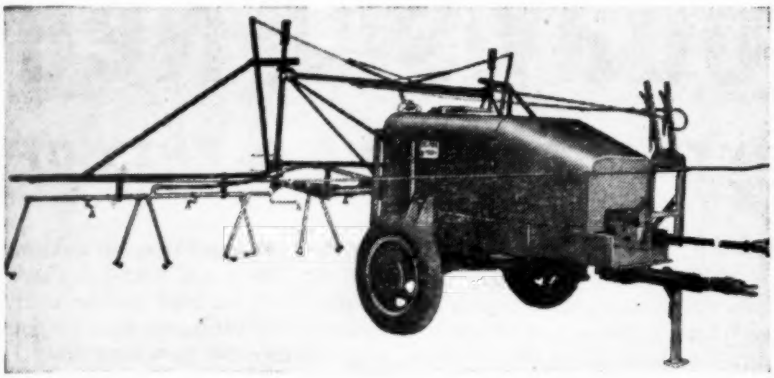

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SECTIONAL NOTES

ALABAMA

Planting operations in the Baldwin County area are proceeding satisfactorily. Our earlier estimates of 12,000 acres were low. At the present time it would appear that the average would be about 16,000 as compared with 24,000 for last year.

Our labor conditions are critical because of the nearness of the Baldwin County area to the shipyards in Mobile and other coastal towns.

The seed for this year has been better than the average.

There is a strong shift to the Sebago variety which is replacing the White Rose and Chippewa in this area. The Sebago has been planted on a limited scale in the past and it is proving to be a very satisfactory variety. This variety has a tough skin, is able to make a good "comeback" after frost damage, and produces a high percentage of No. 1 potatoes. It is well liked by the markets in most places.

Triumphs, however, will constitute approximately 60 per cent of the crop. (Feb. 8).—L. M. WARE.

NEBRASKA

The situation developing in Nebraska with certified seed stocks appears to be shaping up similar to that which took place in 1943. During 1943, the scramble for seed and table stock came somewhat later than this time of the year, but it undoubtedly brought on black market activities that were more or less uncontrollable in the early spring months.

Certified seed stocks of the better grades have been sold out for some time. Only the lower grade, or throw-out stock remains, which stock usually is sold at a sacrifice on the table stock market. This year, in contrast, tags that specify no grade, are being requested on practically all potatoes that are shippable. Although these potatoes qualify for tags under the Nebraska Certification regulations, it is felt that the potatoes are not being utilized for seed purposes. The procedure is being followed to enable buyers to get table stock above the ceilings set for this class of potatoes. The same thing is probably true of War Approved seed, which is being shipped out to a much greater extent than a year ago. Prices in the case of War Approved seed are at ceiling, as is the case with the first quality certified stock.

The conversion of seed potatoes to table stock channels is beyond the control of the producer, as there is no means of tracing the ultimate use of potatoes which have qualified and have been shipped as legitimate certified or War Approved stock. The system of priority ratings for

shipments of seed over table stock probably contributes to this situation. Without this method of priority ratings, however, it is doubtful if southern growers would have been able to get their seed in time for planting. Certified seed shipments were very much behind schedule before a system was introduced. They are still somewhat behind, but as cars become available, such shipments should be on schedule time within a short period.

We anticipate some increase in certified acreage this coming year. There has been a very active local demand, partially to replace old seed stocks, and the rest are to be used for new certified acreage. The excellent prices having been obtained throughout the season undoubtedly have stimulated the interest in certified production. Despite the increase, the Nebraska certified acreage will probably not reach the peak of approximately four years ago.

This increase in certified acreage probably will result in a decrease in non-certified acreage in the territory. Labor difficulties are more critical than in the past two seasons, and the shift is towards crops taking less labor. The loss in both potatoes and sugar beets is being reflected in an increased acreage, to a certain extent, of corn and beans on the irrigated, and grain crops on the dry land. (Feb. 5).—MARX KOEHNKE.

SOUTH CAROLINA

We anticipate about 2/3 of the normal acreage in this area. Most of our seed potatoes arrived in very good condition. Since our soil and weather conditions have been very favorable for planting during the past week a large proportion of our potatoes will be planted by the 20th of February. (Feb. 16).—C. N. CLAYTON.

TEXAS

(Lower Rio Grande Valley)

To date, no damaging cold weather has occurred to blight the prospects for a good spring potato deal. Good rains have occurred, and the crop is off to a good start, but the dreaded Late Blight has shown up in some Valley fields. The weather has been ideal for the growth and spread of this disease and most unfavorable for the use of spraying and dusting equipment. Protective dusting with copper-clay mixtures has already been started in an attempt to protect that which should be a most valuable crop. (Feb. 5).—W. H. FRIEND.

JOINT MEETING OF THE POTATO ASSOCIATION OF AMERICA AND THE INTERNATIONAL CROP IMPROVEMENT ASSOCIATION (Cont'd.)

NEW AND UNUSUAL POTATO DISEASES

R. W. Goss

The major portion of the time allotted to this subject was spent in a discussion of Purple-top wilt caused by the aster yellows virus. A brief review of the literature was presented which revealed a certain amount of confusion in the minds of many concerning the separation of this disease from others having somewhat similar symptoms. Conflicting reports, based chiefly on observational evidence, regarding the relationship of this virus, the aster leaf hopper and the occurrence of purple-top symptoms, were noted from various sections of the country. Dr. Leach was invited to present the results of his recent experimental work on this disease. He reported the transmission of the disease to potatoes by viruliferous aster leaf hoppers in field and greenhouse experiments He emphasized the long incubation period in the potato and the lack of top symptoms resulting from mid- or late-season infection even though the yield might be materially reduced. Following the appearance of symptoms the disease progresses rapidly, usually causing wilt and death of the plant in one or two weeks and thus the name "purple-top" wilt is most descriptive. He stated that all attempts to transmit the disease from potatoes to potatoes or back to asters had failed and that the disease was not perpetuated through tubers although seed tubers from infected plants usually produce plants with low vigor.

The remaining portion of the period was spent in a presentation of the available information on some of the tuber rots that were either new or easily confused. Those discussed were pink rot, reported from a number of states and easily confused with leak as to tuber symptoms; charcoal rot, which appears somewhat similar to leak and pink rot except for the presence of sclerotia, which however are not so abundant in potato tubers as in some other hosts; and the Pythium disease described by Dr. Person from Louisiana, which causes a sudden wilting of the plants and rot of the tubers and which is distinct from pink rot and leak. A somewhat similar disease was reported from Nebraska as being favored by soil temperatures of 70° to 85° F. and high soil moisture. The identity of the causal organism had not been determined. Dr. Ramsey briefly discussed methods of differentiating these tuber diseases on the market.

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RELIABILITY OF THE STEM-OOZE TEST FOR FIELD IDENTIFICATION OF POTATO RING ROT

L. CARL KNORR

Cornell University, Ithaca, N. Y.

INTRODUCTION

The diagnosis of potato ring rot has been declared by some to be difficult; others have maintained it to be relatively simple. Burkholder (1) has analyzed the reasons for confusion, and concludes ". . . that if one were familiar with potato diseases and especially ring rot in the living plant the disease in the majority of cases could be diagnosed by symptoms alone." With this contention the writer is in agreement.

In every field, however, there are cases where, due to complication by other troubles such as cultivation and drought wilting, hopper and tip burn, early and late blight, other wilt diseases, freezing injury, etc., the diagnosis of ring rot cannot always be certain. Doubtful specimens can, of course, be taken to the laboratory for more detailed study, but for routine field examination, where microscopes and bacterial stains or ultra-violet light equipment are not available, a simple technique for the diagnosis of ring rot in suspicious plants would be useful.

In one of the first papers on ring rot, Spieckermann and Kotthoff (4) as long ago as 1914, pointed out that cross-sections of ring-rot diseased stems often show little white flecks in the periphery of the pith, which consist of cavities filled by bacteria. In 1941 Eide and Rose (2) in an extension folder suggested that such cross-sections of suspicious stems be squeezed to bring out the bacteria present in the form of a milky ooze. No indication, however, was given in this five-sentence account as to the reliability of the method in the identification of potato ring rot.

In the experiment described below, an attempt has been made to

determine how close the agreement is between ring rot infection and the stem-ooze test.

Experimental Detail

Potato plants for this experiment were taken from two plots, each of which was planted to eleven different varieties. One hundred seed pieces of each of these varieties were planted to the row in such a manner that every alternating unit of three seedpieces was ring-rot infected and the remaining units of three were uninfected. Plot 1 was located at Ithaca, New York, on Dunkirk fine sandy loam; the seedpieces were planted on the 25th of May, 1944; and 134 plants were selected at random and pulled on the 29th of August, 1944. Plot 2 was located at Baldwinsville, New York, on Ontario fine sandy loam; the seedpieces were planted on the 24th of June, 1944; and 298 plants were chosen at random and pulled on the 27th of September, 1944.

All pulled plants were brought to the laboratory where they were cut perpendicurlar to the long axis with sterile knives near the point of original seedpiece attachment. The stems were squeezed for the presence of ooze, after which the cut surfaces were smeared on slides for microscopic examination.

Data

Table 1 presents the results of this experiment, with data grouped into the eight possible classes indicated in the column headings. The readings on plants from Plots 1 and 2 have been lumped together since when compared separately one plot with the other, they showed no substantial differences.

Discussion

Of the 432 plants tested, how often was the presence or absence of *Corynebacterium sepedonicum* within the plant correctly demonstrable by the stem-ooze test? The figures in table 1 show that agreement between the Gram-smear reading and the stem-ooze test is incomplete to the extent of only 2.8 per cent. This percentage can be broken down into two components. The first part, amounting to 1.9 per cent of the total plants, represents disagreement that might logically be expected because enough bacteria might be present to give a positive Gram-smear reading and yet not enough to produce sufficient visible ooze for a positive stem-ooze reading. The second part, amounting to 0.9 per cent, represents the extent of error in judgment as to what constituted ooze.

Agreement between infected plants (Gram-smear +) and vine wilting was also considered. Of the total 432 plants, 62 or 14.4 per cent,

TABLE 1—*Measure of agreement between gram-smear test, stem-ooze test, and vine-wilt test.*

VARIETY	Number of Plants in Group							
	G+O+W+*	G—O—W—	G+O+W—	G+O—W—	G+O—W+	G—O+W+	G—O—W+	G—O+W—
Russet Rural	22	32	10	0	1	0	1	0
White Rural	17	19	8	0	0	0	0	0
Irish Cobbler	12	6	4	0	0	0	0	0
Bliss Triumph	0	10	2	0	0	0	0	0
Green Mountain	20	26	4	2	0	0	1	2
Katahdin	10	11	4	0	0	0	1	0
Houma	13	19	7	1	1	0	0	0
Sebago	4	17	3	0	1	0	1	0
Earlaine No. 2	13	10	2	1	1	0	2	0
Pontiac	12	15	3	0	0	0	0	0
Sequoia	34	41	4	0	0	1	0	1
Totals	157	206	51	4	4	1	6	3
Per cent of total plants	36.4	47.7	11.8	0.9	0.9	0.2	1.4	0.7

* G+ = Gram-smear (ring rot) positive (indicated by bacteria whose size, shape and staining reaction are characteristic of *Corynebacterium sepedonicum*).
G— = Gram-smear (ring rot) negative.
O+ = Stem-ooze (ring rot) positive.
O— = Stem-ooze (ring rot) negative.
W+ = Vine wilt (ring rot) positive.
W— = Vine wilt (ring rot) negative.

showed disagreement. Here again it is to be expected that few bacteria will give a positive Gram-smear reading and that the same number might on the other hand produce a negative reading for vine wilt. The percentage of disagreement due to this logical behavior is 12.8, and the percentage representing erroneous judgment as to what constituted ring rot wilt is 1.6.

To recapitulate in somewhat different terms what has been said about the figures in table 1, the percentage of plants which were correctly diagnosed by external vine symptoms is 85.6; the percentage correctly diagnosed by the stem-ooze test, 97.2. It is to be emphasized that the stem-ooze test is only relative to the actual diseased condition, that it is not an absolute indicator which can be relied on completely in deciding such questions, for instance, as whether a field entered for certification is disqualifiable. Though small, there does exist a percentage of error which may go in either direction. For example, there are 4 cases (0.9 per cent) in which healthy plants were called diseased, and there are also 8 plants (1.8 per cent) which were stem-ooze negative but which in reality were diseased. The stem-ooze test is not advocated to take the place of more accurate but time-consuming laboratory examinations; it is, however, suggested as an improvement over field diagnoses which heretofore have been dependent on external vine and tuber symptoms alone.

No systematic record was kept concerning the relationship of the above three tests to the occurrence of ring rot in the tubers. In the case of three hills, however, it was noticed that all tubers were sound externally and internally when examined with the naked eye, but that the stems of these plants gave ooze readings which were positive.

Technique

The method used in making the stem-ooze test has been to make a cross-section of the suspected stem at a location as close as possible to the point of original seedpiece attachment. It is to be expected that bacteria in an infected plant will occur first at this locus before appearing in the stolons, tubers, and aerial parts, provided the plant has been infected through the seedpiece as is most always the case with ring rot; and a study by Sherf (3) confirms this expectation. If the basal portion of the stem is rotted, a locus higher up in sound tissue should be selected for the cut.

A pair of hand pruning shears is a convenient tool to use in making stem-ooze tests since, first, the cross-section can be made with a single snip of the shears, and second, the tool then can be used for squeezing,

much like a pair of pliers. If any large number of plants are to be examined for ooze, use of such a tool is almost mandatory since more pressure is needed than can conveniently be applied with forefinger and thumb.

Care must be directed toward differentiating between true bacterial ooze and ooze-like plant juice. The latter may appear milky because of the tiny bubbles of air which come to the cut surface along with the expressed juice. True bacterial ooze is identifiable in a number of different ways. The place of its occurrence is characteristic; it appears at a point or along a line between the woody vascular ring and the pith. Normal plant juice, on the other hand, comes out all over the cut surface. In color, bacterial ooze is similar to milk, and in consistency varies (depending on the number of bacteria and the amount of plant juice mixed with them) from that of approximately the normal juice to that of coherent little flecks or platelets. All of the stem-ooze readings in table 1 were made with the naked eye, but it is likely that the use of a hand lens will make possible more accurate differentiations between bacterial ooze and foamy juice.

Another characteristic of the ring-rot invaded stem is that at the locus of oozing the vascular ring is easily separable from the adjacent pith—a condition which does not exist in the case of the uninfected stem.

Two common potato-infecting bacteria which might be supposed to yield ooze in a test of this kind are *Bacterium solanacearum,* the cause of brown rot, and *Erwinia phytophthora,* the cause of blackleg. However, neither of these offer any difficulty. In the case of brown rot, a brown stain appears in the diseased vascular ring; no such discoloration is visible where ring rot is concerned. The blackleg pathogene causes a marked slimy rotting of the basal stem, a condition also never caused by ring rot.

Summary

The field diagnosis of potato ring rot often is complicated by other vine disturbances such as cultivation- and drought-wilting, tip- and hopper-burn, early- and late-blight, other wilt diseases, frost killing, and the like. A serviceable test under such conditions consists of cutting the suspected stem near the point of original seed-piece attachment, squeezing the stem at the cut, and looking for a pearly, milky, viscous exudate at a locus or line between the woody vascular ring and the pith. In the case of plants infected through the seedpiece, *Corynebacterium sepedonicum* occurs in the new plant first at the point of attachment to the mother seedpiece; only later are the bacteria demonstrable in other parts of the plant such as the tubers and the aerial vines.

Four hundred and thirty-two potato plants, representing 11 varieties, grown under two different field environments, and planted and harvested on two different dates, were used to determine the degree of relationship between presence of ring rot (indicated by positive Gram smears) and the occurrence of external vine wilt and of stem ooze.

The percentage of plants which were correctly diagnosed by external vine symptoms was 85.6. The percentage of disagreement due to few bacteria resulting in positive Gram smears but insufficient to produce wilting, amounted to 12.8. The percentage representing erroneous judgment as to what constituted ring-rot wilt was 1.6.

The percentage of plants which were correctly diagnosed by stem-ooze tests was 97.2. The percentage of disagreement due to few bacteria resulting in positive Gram smears but insufficient to produce stem ooze, amounted to 1.9. The percentage representing erroneous judgment as to what constituted ooze amounted to 0.9.

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OBSERVATIONS ON GENETIC, PHYSIOLOGICAL, AND ENVIRONMENTAL FACTORS AFFECTING THE VITAMIN C CONTENT OF MAINE-GROWN POTATOES[1]

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The potato has been analyzed with reference to its nutrient quality by many investigators. Its palatability as a species is practically universal, and its basic nature makes its nutritive contribution of greatest importance. Because of this fundamental dietary position, genetic differences in any nutritive essential and variations caused by external influences are of significance. Because Maine ordinarily produces 12

[1]Paper 244 from the biological laboratory of the Maine Agricultural Experiment Station.

per cent and in 1943 produced 16 per cent of the country's potatoes (Schrumpf '43), and because in at least some sections potatoes constitute a chief source of vitamin C to Maine inhabitants, almost to the exclusion of other fresh vegetables (Murphy '41), the vitamin C values of some of the varieties of Maine-grown potatoes, observations on factors affecting these values, and the relationship between vitamin C values and other characteristics were deemed worthy of study.

The vitamin C content of the potato has been reported as being on a low level when compared on a weight basis with oranges, broccoli, cabbages, tomatoes, and other so-called rich sources. It is pointed out by Dove ('43), however, that its "appetite level" is such that it assumes a primary position as a source of supply to the consumer. That potatoes, cooked by the techniques employed by housewives in certain sections of Maine, although consumed in large amounts, do not furnish sufficient vitamin C to maintain physiological saturation at the recommended level, was evident from a study carried on in this state (Crane and Woods '41). The need was shown for larger intakes of vitamin C. This could be effected by the more liberal use of foods potent in this factor. The deficiency could be ameliorated with the same dietary by substituting varieties of higher vitamin C content—effecting the increased potency either by means of genetic selection or by an improvement in storage and cooking methods or by a combination of the two. It has been observed that the ascorbic acid of potatoes is well utilized physiologically (Clayton '40).

Method

The analytical method used to determine the ascorbic acid in potatoes was a modification of the technique published by Bessey and King ('33). Suggestions of Morrell ('41), Musulin and King ('36), and Bessey ('38) were used in the adaptation of method.

Each sample weighed between 15 and 20 grams. It consisted of a radial sector from each of two potatoes. Duplicate samples comprised radial sectors from the opposite sides of the same tubers. Because ascorbic acid has been reported by Rolf ('40) to be unevenly distributed within the tuber the sectors were taken along the axis from bud to stem end in order to include the more concentrated bud end and the less concentrated stem end. Thus the samples were as nearly comparable as present knowledge would permit. Measurements of the length (bud to stem end), width, and depth were recorded as were flesh color, skin color, and depth of eye. The peel was not removed from the samples, in order to increase the speed of analyses and to

lessen the possibility of oxidation while preparing the sample as well as to obviate the possibility of uneven paring of the samples. The samples were weighed and dropped into the glass containers of the Waring Blendor. Five per cent metaphosphoric acid was added in an amount such that the final content of liquid would equal 100 ml. The amount added was calculated on the basis of 79 per cent moisture in potatoes (Morrison '36). The mixture was then ground in the blendor for 3 minutes when it was usually homogeneous throughout. Occasionally it was necessary to grind for five minutes to obtain homogeneity. The resulting suspension was immediately filtered under suction through Whatman Filter Paper No. 42. Filtration was speedy and the resulting filtrate clear. A small fraction was discarded. Aliquots of the remaining filtrate were titrated according to the method outlined by Bessey and King ('33). By means of this technique it was found possible to complete 60 to 70 determinations in a day.

The potato samples were furnished from the U. S. D. A. 1942 trial plots which were randomized with three replicates. They were grown under similar cultural conditions at Presque Isle, Aroostook County, Maine on Caribou loam soil which tended to be acid (approximately between pH 4.6 and 5.0). There were 54 varieties which included 22 leading commercial varieties, 14 promising seedlings (3 of which have since been named), 2 wild varieties from South America, and 16 German varieties which were on trial as sources of potato starch. Six of the commercial varieties were grown at Orono, Maine.

The potatoes were harvested on the 15th of September and testing was started on the 8th of October and completed on the 23d. The tubers were held during the interim in normal storage, the temperature of which was not controlled. Usually at that season of the year the storage temperatures average 50° to 55° F. Thus all of the samples were subject to the losses of vitamin C which occur during three to four weeks' storage. It has been observed that one month's storage at 50° F. caused an average loss of 33 per cent in 6 potato varieties (Murphy '44).

Results

The ascorbic acid values resulting from these analyses are shown in tables 1, 2, and 3, and the distribution is set forth in figure 1. These values represent an average of 2 to 16 tests for each variety for one year only.

On the basis of the figures herein reported it is shown that raw potatoes grown in Aroostook County in 1942 had ascorbic acid values

TABLE 1. *Ascorbic acid content of Aroostook-grown potatoes, commercial varieties.*

Variety	No. of Samples	Range Mg. per 100 G.	**Mean Mg. per 100 G.
Triumph	6	28 to 31	30 ± .23
Chippewa	12	22 to 25	23 ± .20
Earlaine	6	28 to 32	30 ± .41
Earlaine No. 2	6	26 to 29	27 ± .33
*Early Ohio	4	27 to 29	28 ± .24
*Garnet Chili	4	22 to 24	23 ± .28
*Golden	4	21 to 24	22 ± .41
Green Mountain	12	26 to 32	30 ± .45
Houma	8	31 to 38	34 ± .73
Irish Cobbler	12	21 to 30	25 ± .48
Katahdin	12	32 to 38	35 ± .37
Mesaba	6	29 to 35	32 ± .52
Mohawk	6	34 to 37	36 ± .32
Pontiac	8	27 to 35	30 ± .56
Red Warba	8	23 to 31	27 ± .66
*Rural N. Y. No. 2	8	28 to 41	33 ± .96
*Rural Russet	4	22 to 27	25 ± .77
*Russet Burbank	4	23 to 27	24 ± .55
Sebago	16	29 to 42	35 ± .61
Sequoia	6	35 to 42	38 ± .64
Warba	6	27 to 30	29 ± .39
White Rose	6	36 to 38	37 ± .23

*Grown at Orono, Me.

**Least difference required for significance between fifty replicated varieties at the 1 per cent level (odds 99 to 1) by variance analysis is 5.8 mg. and at the 5 per cent level (odds 19 to 1) is 4.3 mg.

TABLE 2. *Ascorbic acid content of Aroostook-grown potatoes, seedling selections.*

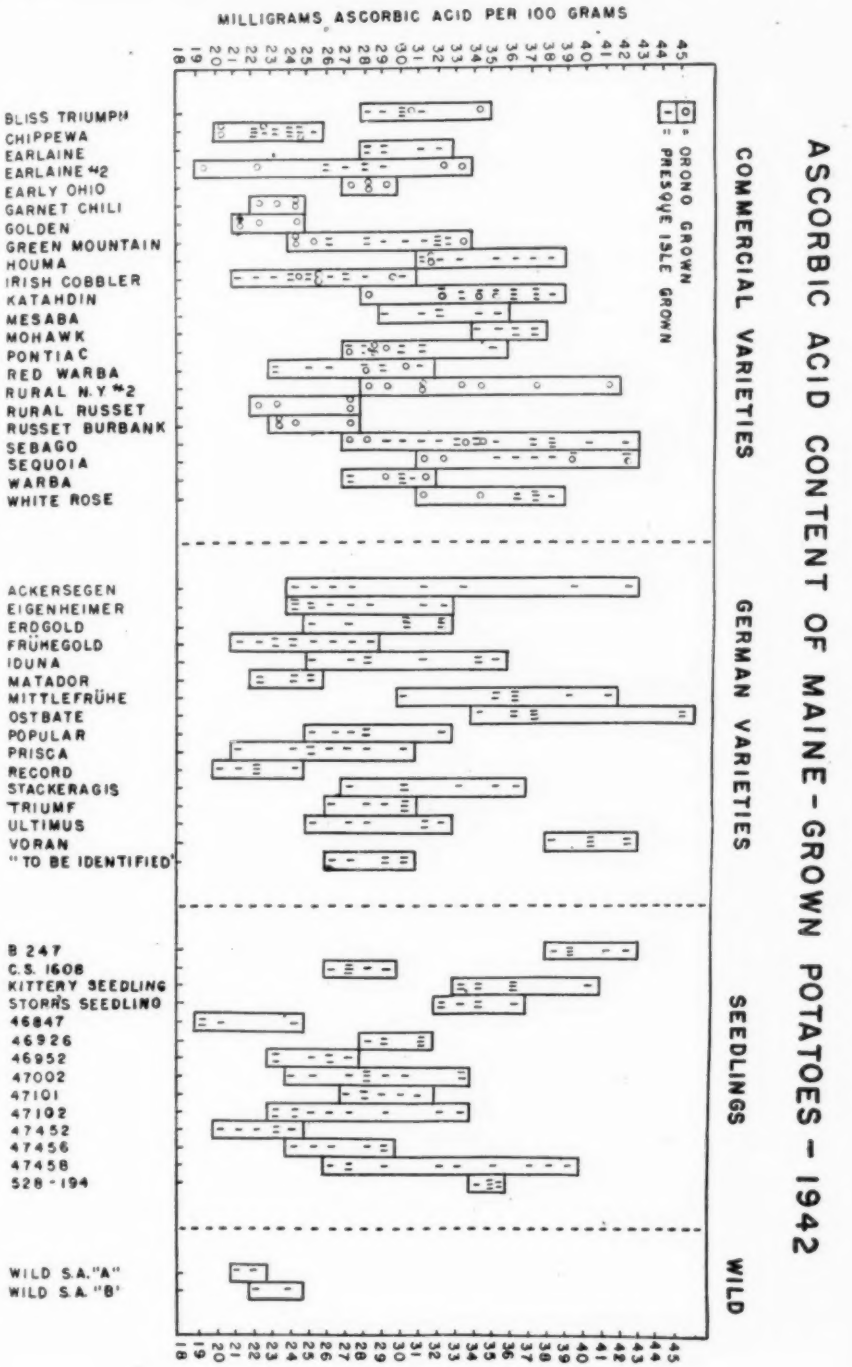
Variety	No. of Samples	Range Mg. per 100 G.	Mean Mg. per 100 G.
B 247 (Potomac)	6	38 to 42	40 ± .35
CS 1608 (Pawnee)	6	26 to 29	27 ± .28
Kittery Seedling	8	33 to 40	35 ± .52
Storr's Seedling	6	32 to 36	34 ± .38
46847	4	19 to 24	20 ± .70
46926	6	28 to 31	30 ± .36
46952	6	23 to 27	25 ± .42
47002	10	24 to 33	28 ± .60
47101 (Erie)	6	27 to 31	29 ± .39
47102	10	23 to 33	27 ± .73
47452	6	20 to 24	22 ± .35
47456	6	24 to 29	27 ± .55
47458	10	26 to 39	32 ± .99
528-194	6	34 to 35	35 ± .17
Wild S.A. "A"	2	21 to 22	22 ± .24
Wild S.A. "B"	2	22 to 24	23 ± .48

TABLE 3. *Ascorbic acid content of Aroostook-grown potatoes, German varieties.*

Variety	No. of Samples	Range Mg. per 100 G.	Mean Mg. per 100 G.
Ackersegen	8	24 to 42	31 ±1.49
Eigenheimer	10	24 to 32	27 ± .59
Erdgold	8	25 to 32	30 ± .57
Frühegold	10	21 to 28	24 ± .45
Iduna	8	25 to 35	30 ± .84
Matador	6	22 to 25	24 ± .33
Mittlefrühe	8	30 to 41	36 ± .72
Ostbote	8	34 to 45	38 ± .93
Popular	6	25 to 32	28 ± .60
Prisca	8	21 to 30	26 ± .61
Record	6	21 to 24	22 ± .35
Stackeragis	6	27 to 36	32 ± .87
Triumf	6	26 to 30	29 ± .42
Ultimus	6	25 to 32	29 ± .69
Voran	6	38 to 42	40 ± .40
To be identified	6	26 to 30	28 ± .41

comparable to raw tomatoes. The lowest popular commercial variety, Chippewa, had an average content of 23 mg. per 100 grams fresh weight—a level similar to many commercial varieties of tomatoes. The highest values observed for commercial varieties included Potomac, at 40; Sequoia, at 38; White Rose, at 37; Mohawk, at 36; and Katahdin and Sebago at 35 mg. per 100 grams. These latter figures are at the level of Farthest North C, Comet, and Best of All tomatoes which varieties have shown the highest vitamin C values of tomatoes observed in this laboratory over a period of years. At potato consumption levels of 92, 85, and 114 grams per day, shown by Dove ('43) to be desired by 3 representative groups of consumers, raw Chippewa potatoes could furnish nearly one-third of a daily vitamin C requirement of 75 mg., and the high-vitamin C varieties about one-half. Storage and cooking losses would lessen this contribution.

On the other hand, potatoes are apparently not always so potent in vitamin C as this investigation shows. Fixsen and Roscoe ('37-'38) list in their review one value as high as 53 mg. per 100 grams, Smith and Gillies ('40) report Redskin at 26.7 after one month's storage and immature Arran Banner at 34 mg. per 100 grams. Rolf ('40) reported one tuber of Chippewa as high as 26.4 mg. per 100 grams. Karikka, Dudgeon, and Hauck ('44) found that during one season three varieties showed mean values between 40 and 45 mg. per 100 grams. One individual sample was 54 mg. per 100 grams. Other in-


ASCORBIC ACID CONTENT OF MAINE-GROWN POTATOES - 1942
MILLIGRAMS ASCORBIC ACID PER 100 GRAMS
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45
= ORONO GROWN
= PRESQUE ISLE GROWN
COMMERCIAL VARIETIES
BLISS TRIUMPH
CHIPPEWA
EARLAINE
EARLAINE #2
EARLY OHIO
GARNET CHILI
GOLDEN
GREEN MOUNTAIN
HOUMA
IRISH COBBLER
KATAHDIN
MESABA
MOHAWK
PONTIAC
RED WARBA
RURAL N.Y. #2
RURAL RUSSET
RUSSET BURBANK
SEBAGO
SEQUOIA
WARBA
WHITE ROSE
GERMAN VARIETIES
ACKERSEGEN
EIGENHEIMER
ERDGOLD
FRÜHEGOLD
IDUNA
MATADOR
MITTLEFRÜHE
OSTBATE
POPULAR
PRISCA
RECORD
STACKERAGIS
TRIUMF
ULTIMUS
VORAN
"TO BE IDENTIFIED"
SEEDLINGS
B 247
C.S. 1608
KITTERY SEEDLING
STORR'S SEEDLING
46847
46926
46952
47002
47101
47102
47452
47456
47458
528-194
WILD
WILD S.A. "A"
WILD S.A. "B"

vestigators observe raw potatoes to contain less ascorbic acid than these high values. In this laboratory Aroostook-grown potatoes of some of the same varieties have been analyzed previous to 1942 with resulting values lower than those of that year as shown in table 4.

The 1942 season was characterized by less than average rainfall. Precipitation at Presque Isle was 17.76 inches in 1938, 15.78 inches in 1939; and 12.33 in 1942 for the period from the 1st of June to the 1st of October. The 17-year average for this 4-month period is 14.76 inches. Thiessen ('36) analyzed potatoes grown with and without irrigation and observed that those grown on dry land had a slight advantage over the irrigated in vitamin C content as measured by means of bioassay.

Several investigators have pointed to an increase in light intensity as being responsible for increased synthesis of ascorbic acid (Reid '42, '42a; Murphy '38, '42; Moldtmann '39; Reder *et al.* '43). If light intensity is a contributing factor in ascorbic acid synthesis, as seems to be the case in regard to some crops, the effect on potato tubers would necessarily be an indirect one—with the actual synthesis occurring in the leaves and subsequently translocated to the underground tuber. The only records available regarding sunlight at Presque Isle are in terms of clear, partly cloudy, and cloudy days. The records of total number of clear days during 1938, 1939, and 1942 show no striking differences. In fact the 1942 season, when vitamin C levels were highest, had fewer clear days, with 35 recorded from the first of June until the first of October, than had 1938 with 38 clear days, or 1939 with 41. These data are not satisfactory because days recorded as partly cloudy or cloudy may vary widely in actual light intensity.

The larger figures resulting from potato analyses in 1942 when compared with those of previous seasons brought the new technique under suspicion. By calculating the final volume of liquid on the basis of 79 per cent moisture in potatoes and using an aliquot of the filtrate for titration, a speed was attained which was not possible if each sample were completely extracted, transferred quantitatively to flasks, and made up to a definite volume. However, if errors were involved which would result in erroneously high results, the newer speedier method would have to be discarded. To determine the relative merits of the two methods, adjacent radial sectors from the same tubers were analyzed by each of the two techniques. It was found from 10 pairs of these samples (from 2 varieties) that the older volumetric technique gave values which were 10.5 per cent higher

than the new technique. Duplicate samples analyzed by the old technique varied to the extent of 8.4 per cent, and by the new method to the extent of 6.3 per cent. The small difference resulting from the two methods and the great advantage of speed attached to the newer technique seemed to justify its continued use. The values resulting from analyses by the two techniques were of the same degree of magnitude, evidence that the analytical method in use during 1942 was not responsible for the higher assay values for vitamin C in potatoes.

A further point which was considered as a possible explanation for the high 1942 values was the presence of the potato peel on the sample. If vitamin C was disproportionately high in the peel, the data would be weighted to give inordinately large values. Four samples representing three varieties were peeled and the parings and flesh were analyzed separately. There was a tendency for the peelings to have lower values. When the data were treated statistically according to Student's method for paired samples, the odds were 22 to 1 in favor of the flesh. A larger number of samples might have shown more significant differences or minimized them. However, the values of the four pairs of samples were close enough to obviate the possibility that the inclusion of the parings was responsible for the large discrepancy in seasonal values.

The length of storage time may be partly responsible for the lower values of 1938 and 1939. The 1938 samples were analyzed during the period from the 4th to the 18th of November, those of 1939 from the 13th to the 15th of December, while those of 1942 were completed during October.

Effect of Variety

Lyons and Fellers ('39) observed that the differences between are less than the differences within a variety. Scheunert *et al.* ('40, '40a) noted that the variations between samples in any one lot of potatoes are greater than the variations due to origin and concluded that no superiority may be attached to variety. Smith and Gillies ('40) who tested potatoes from the same lot during storage, stated that differences exist in association with varieties which are outside the range of experimental error. They pointed out that these variations may be due to stage of maturity or storage conditions. Idjo ('37) reported not more than 10 per cent variation between individual potatoes of the same variety and differences up to 60 per cent between varieties. Smith and Paterson ('37) observed that ascorbic acid pro-

vides a useful means of discriminating between varieties under similar storage conditions. Wachholder and Nehring ('39) noted that although potato crops of different seasons vary in ascorbic acid, the relative rank of varietal amounts is about the same. Tedin ('41), on the other hand, observed that 20 per cent variation existed within variety and that the rank is not always the same from one locality to another. Zilva and Barker ('39) noted that the vitamin C content of potatoes varies markedly with variety. Wachholder and Nehring ('40) concluded that the initial vitamin C value in potatoes is a varietal characteristic. Karikka, Dudgeon, and Hauck ('44) found significant varietal differences during three seasons, with Katahdin and Houma showing high values and Chippewa low.

Fifty of the varieties listed in tables 1, 2 and 3 were grouped together for analysis by the variance method. The six Orono-grown varieties were omitted, as well as two wild varieties and the seedling 46847, because these were not replicated. On the other hand, Green Mountain, Katahdin, Sebago, Chippewa and Irish Cobbler were grown in three replications on each of two plots. These duplications were considered as separate samples. By variance analysis, there were found to exist highly significant differences between varieties. The least difference required between means for significance at the 1 per cent level (odds 99:1) is 5.8 mg. It may be seen in tables 1, 2, and 3 that many of the varieties differ to that extent from one another. No significant difference was found between replicates.

Varietal similarity as noted by Scheunert, Reschke, and Kohleman, ('40) in regard to potato vitamin C is possibly explained by the limited number of varieties tested which may have been of similar genetic constitution. Two of the three varieties which they tested, Erdgold and Ackersegen, were included in the present study. The former had a mean value of 30 and the latter of 31 mg. per 100 grams. Lyons and Fellers ('39) observed that values differed widely within a given variety. Their sample material came from many sections of the country and was thereby subject to environmental influences at the place of origin as well as to the varying conditions and time intervals involved in transportation. In the investigation herein reported, varietal differences were brought to light because of the wide range of material sampled (54 varieties of diverse parentage) and because influences which induce variable losses were minimized by the imposition of similar soil, cultural, environmental, and shipping conditions.

It appears from these data that variety is an important factor

to be considered in all nutritional investigations and calculations. It has been pointed out previously that, although environmental conditions markedly influence vitamin C synthesis, superiority of origin manifests itself even under an adverse environment (Murphy '42). Analyses of 7 comparable varieties of Aroostook potatoes for three seasons demonstrate significant differences between varieties in each year. With the exception of one variety in 1942 (Green Mountain), the relative positions of the varieties with regard to vitamin C are maintained with minor overlapping. The vitamin C values for the three years are shown in table 4.

When the data were reduced by the variance method, it was found the "between seasons" differences required for significance are 3.9 mg. at the 1 per cent level and 2.8 mg. at the 5 per cent level. The three seasonal means are 14.1 mg. per 100 grams for 1938, 15.7 for 1939, and 28.4 mg. for 1942 which indicates that environmental conditions have a marked influence upon the vitamin C values of crops manifesting themselves even in underground tubers. Between varieties the required differences are 6.0 mg. at the 1 per cent level and 4.3 mg. at the 5 per cent level. Hence it is obvious that the lower magnitude varietal values are significantly and consistently different from those of higher magnitude.

The results of this study show that genetic constitution is undoubtedly a determining and limiting factor in vitamin C synthesis in plants. That there is overlapping of values between varieties and wide variations within varieties is obvious from figure 1. However, there is a definite tendency for tubers of one variety to be higher than those of another. In these analyses duplicate tests were found to differ by 1.45 mg. and replicates by 3.1 mg.

The optimum expression of vitamin synthetic potentialities in plants apparently is dependent upon environmental factors. Whether varieties vary in their response to these outside elements or whether certain varieties are more resistant to the influence of extraneous factors are points which require investigation. It seems extremely likely that the ascorbic acid of certain varieties may be found to resist chemical change to a greater extent than in other varieties if one may judge by varietal response to processing and storage conditions. The vitamin C of three varieties of tomatoes has been seen to oxidize at quite different rates during processing for tomato juice (Monroe and Murphy '43) and the effects seem consistent as to the variety. Some varieties of potatoes during storage (Murphy '44) as well as during cooking seem peculiarly resistant to ascorbic acid oxidation

TABLE 4. *Ascorbic acid values for seven potato varieties during three seasons.*

Variety[2]	1938[1]		1939[1]		1942[1]		3-year Average Mg. per 100 Gms.
	No. of Samples	Mg. per 100 Grams	No. of Samples	Mg. per 100 Grams	No. of Samples	Mg. per 100 Grams	
Earlaine	2	10.4	1	18.7	6	29.5	22.5[2]
Houma	3	18.2	1	17.3	8	34.1	23.2
Sebago	3	14.4	2	19.6	16	35.1	23.0
Irish Cobbler	3	12.3	1	13.7	12	25.2	17.0
Green Mt.	3	12.7	2	12.4	12	20.8	18.3
Chippewa	3	11.6	1	15.9	12	23.2	16.9
Golden	3	9.9	1	12.1	4	22.0	14.7
Average		14.1		15.7		28.4	

[1]The least difference required for significance between seasons is 3.9 mg. at the 1 per cent and 2.8 mg. at the 5 per cent levels by variance analysis.

[2]The least difference required for significance between varieties is 6.0 mg. at the 1 per cent and 4.3 mg. at the 5 per cent levels by variance analysis.

under conditions similar to those in which other varieties lose markedly. By re-analysis of data published by Lyons and Fellers ('39) it is seen that the Katahdin variety loses at a slower rate in baking or boiling and in storage under two conditions than do three other varieties, whereas the Houma appeared to lose at the greatest rate during baking and under two conditions of storage. Chippewa and Green Mountain were intermediate although there was a tendency for the Chippewa to be more stable. Although no evidence exists to demonstrate that varieties of field-grown crops vary in their response to external influences in relation to vitamin C synthesis, the known facts of varietal resistance to disease, varietal adaptability to soil and cultural conditions, and varietal reactions to cold and heat, seem to justify an assumption of varietal stimulation or depression in vitamin C synthesis in response to external factors.

Locality and Season

Thiessen ('36) observed that, except for the effect of irrigation as noted above, other variable conditions of cultivation had little effect and the Triumph variety remained fairly constant as regards vitamin C during four seasons. Idjo ('37) reports ascorbic acid of potatoes as being little affected by the locality of production. Lyons and Fellers ('39) analyzed potatoes from six states and found no significant differences. Scheunert *et al.* ('40) concluded that no superiority in the vitamin C content of potato could be ascribed to place of origin. On the other hand Tedin ('41) reports that a given variety shows regional differences and suggests that potatoes from south Sweden are higher in vitamin C than those from the north. Karikka *et al.* ('44) found significant differences in the vitamin C content of potatoes grown in four counties in New York. Wachholder and Nehring ('40) analyzed potatoes from several places and observed differences large enough to warrant their conclusion that soil or other local conditions are more important with respect to vitamin C production than either fertilization or variety. They reported a relationship with the pH of the soil; but Karikka, Dudgeon, and Hauck ('44) found no indication of an effect of soil reaction on the vitamin C of potato tubers.

Thirteen of the potato varieties included in the present study had also been grown at Orono, Maine. Orono is situated on latitude 44° 54′ 2″ whereas Presque Isle is situated on 46° 40′ 30″. Soil and cultural conditions were not controlled. All tubers were harvested and analyzed at approximately the same time. The Presque Isle values for

vitamin C were slightly higher than those obtained from Orono-grown tubers, with a mean difference of .92 mg. per 100 grams. The standard deviation was 2.88 with odds of six to one against the chance occurrence of the difference. The coefficient of correlation for this group of varieties as grown in two localities, was .79 ± .07. Thus in 1942 potatoes grown in two localities in Maine, 150 miles apart and differing by almost 2° in latitude, showed no significant difference in vitamin C content because of locality, but exhibited similar varietal differences. Because marked seasonal differences have been shown above to occur in the vitamin C content of potatoes, it is justifiable to conclude that the environmental factors that determine the ascorbic acid production of potatoes were similar in Orono and Presque Isle during the 1942 season. Locality differences, when they do occur, seem to be the result of extraneous influences which vary with season and locality. Locality is a significant factor in vitamin C production only in so far as these influences are characteristic and consistent in the locality.

Effect of Size and Shape of Tuber

Several investigators (Lyons and Fellers '39, Rolf '40, Smith and Paterson '37, Idjo '37, Karikka *et al.* '44) reported that the vitamin C content of potatoes is independent of tuber size. Results of the analyses reported herein confirm their observations.

At the time of sampling, measurements of length, width and thickness of the tubers were recorded. The correlation coefficient for the volume of the tubers (as calculated from these measurements) and the vitamin C content was .0063 ± .0564 when all of the replicate samples were treated individually. When the vitamin C values and volumes were averaged for variety, the correlation coefficient was .1154 ± .0992. Neither of these figures demonstrates a significant correlation.

There appeared to be no relationship between the vitamin C values and the shape of the tubers. The correlation coefficient in the case of tubers that had greater length than width was—.1743 ± .0898 and of those that had greater length or width than thickness was .0943 ± .0918.

Relationship to Starch Content

Nineteen of the varieties included in this study were analyzed by Dr. C. A. Brautlecht[2] for their content of starch during 1942. There

[2]Brautlecht, C. A. 1943. Experimental potatoes. Me. Agr. Exp. Sta. Bul. 420:457, 482.

appeared to be no association between starch and vitamin C content (table 5).

TABLE 5. *The starch content of potatoes in relation to vitamin C values,* 1942.

Variety	Per cent Starch	Ascorbic Acid Mg. per 100 Grams
Stackeragis	18.5	32
Record	18.5	22
Popular	17.9	28
Ostbote	17.7	38
Green Mountain	17.7	30
Ackersegen	17.6	31
Ultimus	17.5	29
Triumf	17.4	29
Prisca	17.3	26
Eigenheimer	17.2	27
Erdgold	17.1	30
Sebago	16.7	35
Iduna	16.5	30
Voran	16.4	40
Matador	16.4	24
Mittlefrühe	16.0	36
Irish Cobbler	15.1	25
Frühegold	14.7	24
Katahdin	13.9	35

RELATION OF PARENT TO PROGENY IN TERMS OF VITAMIN C

While this study was being pursued it was found that one or both parents of some of the varieties were represented in the groups. An attempt was made to obtain other related samples but many of the parent seedlings had been discarded and a few which were still existent were unobtainable at the time.

The values resulting from analyses of available related varieties are shown in table 6. There is a tendency for high parents to produce medium to high offspring and for low parents to produce medium to low progeny. Katahdin is one of the parents for 9 of the varieties represented, 6 of which have values as high as or higher than Katahdin. The other parent varied from low to high. Earlaine, on the other hand, is a parent of six of the varieties, all of which show values lower than Earlaine. Katahdin, a high-testing variety, and Chippewa, a low-testing variety, are progeny of the same parents, neither of which was available for analysis.

TABLE 6. *Vitamin C values for parents and progeny in potato varieties of which one or both parents are assayed.*

Parentage Vitamin C Values in Parentheses	No. Tested	Progeny Vitamin C Values	
Green Mountain (30) x Katahdin (35)	3	Mohawk	36
		Sequoia	38
		Storr's Seedling	34
Rural New Yorker (33) x Katahdin (35)	2	Potomac	40
		Pawnee	27
Triumph (30) x Katahdin (35)	1	Pontiac	30
Chippewa (23) x Katahdin (35)	1	Sebago	35
45349 (?) x Katahdin (35)	1	47456	27
Chas. Downing (?) x Katahdin (35)	1	Houma	34
No Blight (21) x Earlaine (30)	1	47452	22
Irish Cobbler (25) x Earlaine (30)	1	47002	28
45146 (?) x Earlaine (30)	2	47101	29
		47102	27
Earlaine (30) x 43055 (?)	2	46926	30
		46952	25
Triumph (30) x Minn. 4-16 (?)	1	Warba	29
Eigenheimer (27) x Neue Imperator (?)	1	Triumf	29
Richter's Jubel (26) x 44537 (?)	1	528-194	35
Irish Cobbler (25) x 43055 (?)	1	Earaline	30
Russet Rural (25) x Minn. 41-1 (?)	1	Mesaba	32

EFFECT OF DISEASE RESISTANCE

Smith and Paterson ('37) analyzed 12 varieties of potatoes for ascorbic acid. They observed that tubers affected with mosaic or leaf roll were significantly higher in vitamin C content than were healthy tubers. Conversely those affected with blight showed lower values than healthy stock. They pointed out a relationship between the susceptibility of a potato variety to virus disease and its content of ascorbic acid, the susceptible varieties testing lower than the resistant ones. Later work by Smith and Gillies ('40) showed a greater concentration of vitamin C in tubers from plants affected with severe mosaic or leaf roll than in tubers presumed to be healthy. Thiessen ('36) reported that scabby potatoes had a normal supply of vitamin C when freshly harvested and during 3 months of storage. Thereafter loss in storage was greater in scabby than in healthy tubers.

Recent literature was scanned[3] and authorities[4] were consulted to determine the resistance of the 54 tested varieties to 13 diseases which commonly affect Maine potatoes. In table 7 are listed groups of high-vitamin C varieties (34 to 40 mg. per 100 grams); low-vitamin C varieties (21 to 25 mg. per 100 grams); and 2 varieties showing values of 30 mg. per 100 grams. Ratings for each disease are given each of these varieties in grades from 1, very susceptible, to 8, very resistant. These ratings indicate the consensus regarding resistance of varieties to the diseases indicated. It must be pointed out that an attempt was made to limit the data to investigations carried out in Maine on Maine-grown potatoes although in some instances, where data were lacking for Maine, results from other sections and other countries were utilized. Also it must be realized that the ability of plants to withstand any disease is influenced by environmental factors and physiological conditions. A variety which ordinarily is resistant to a disease may under adverse conditions become completely affected (Rieman and McFarlane '43). It will be noted from table 7 that the vitamin C values of the varieties included in this study are not related to resistance to the diseases under consideration. Tables of distribution were made by plotting the vitamin C values of all of the varieties against the relative disease resistance (again using 1 to 8 to

[3]Rev. App. Mycol. 14:606. 1935; 16:54, 403. 1937; 17:413, 483. 1938; 19:564, 672. 1940.
Amer. Potato Jour. 13:205-218, 256-259. 1936; 15:130-140, 246-252. 1938; 17:217-235. 1940; 19:24-29. 1942; 20:79-86. 1943.
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Mimeog. Office Rpt. from Bureau Plant Industry Station, Beltsville, Md., 28-31, April, 1943.

[4]Acknowledgment is accorded to Dr. Donald Folsom, Dr. Reiner Bonde, and Dr. Merle Hilborn for assistance in determining disease resistance and in interpreting the literature.

TABLE 7. *Degree* of disease resistance of potato varieties in relation to their vitamin C content.*

Variety	Vitamin C Mg. per 100 Grams	Late Blight	Leaf Roll	Net Necrosis	Bacterial Ring Rot	Rhizoctonia	Stem-end Browning	Internal Mahogany Browning	Scab	Spindle Tuber	Purple Top	Mosaic		
												A	X	Y
Voran	40	8				2			6			2		2
B 247 (Potomac)	40	6				2								
Sequoia	38	6	2		2	2	3		2	2	2			
Mohawk	36	2	5	7	2	8		3	2			7		2
Sebago	35	6	5	7	2	2	7	3	5	2	1	8		7
Katahdin	35	2	7	8	2	5	7	2	2	2	2	7	3	7
Houma	34	1	8		1	2	4	2	4	2		7		2
Green Mountain	30	1	2	2	1	2	2	7	1	2	4	2	2	4
Triumph	30	2	2		2	5			1	2	2	2	2	1
Irish Cobbler	25	2	2	3	1	2	1	6	1	2	3	7	2	2
Russet Rural	25	1			2	2	2		6	2	2	2	2	2
Russet Burbank	24	2			2	2			7	2	2			6
Chippewa	23	2	2	8	1	2	7	1	1	2	2	8	2	8
Golden	22	2	8		2	2		5	6	2		7		2
No Blight	21	7			8	2	6		4			1	2	2

* 1 = Very susceptible.
2 = Susceptible.
3 = Moderately susceptible.
4 = Relatively susceptible as compared with one or more other varieties.
5 = Relatively resistant.
6 = Moderately resistant.
7 = Resistant.
8 = Very resistant.

indicate degree). Correlation coefficients were calculated from these tables with the following results:

Diseases	N	$r \pm$ P.E.
Internal Mahogany Browning	7	$-.50 \pm .19$
Bacterial Ring Rot	26	$-.33 \pm .12$
Purple Top	14	$-.20 \pm .17$
Leaf Roll	17	$-.19 \pm .16$
Mosaic Y	16	$-.02 \pm .17$
Stem End Browning	13	$-.01 \pm .19$
Spindle Tuber	17	0
Scab	29	$.03 \pm .13$
Mosaic A	15	$.07 \pm .17$
Rhizoctonia	53	$.22 \pm .09$
Late Blight	33	$.26 \pm .11$
Net Necrosis	6	$.31 \pm .25$
Mosaic X	8	$.67 \pm .13$

All of the tubers tested during this study were presumably healthy. None of the varieties was the same as those analyzed by Smith and Paterson ('37).

Effect of Maturity

Of the potato varieties under test, 10 were classified as early-maturing; 20 as late-maturing; and 20 as starch varieties. All varieties were planted on the 6th of May and harvested on the 15th of September, 1942. At harvest time, the foliage of all of the varieties in the early yield test was dead. In general, all the late varieties were still immature, and showed some green foliage. The starch varieties were also late in maturing, with the exception of Irish Cobbler. The early group usually matures 10 to 15 days before the late,—most varieties of which never mature in Maine.

Thirty-two samples from the 10 early-maturing varieties had a mean value of $27.8 \pm .36$ mg. per 100 grams. Sixty-eight samples from the 20 varieties characterized as late-maturing resulted in a mean of $31.6 \pm .43$ mg. per 100 grams. The mean difference was $3.8 \pm .56$ mg. per 100 grams in favor of the late-maturing varieties.

As all varieties were harvested on the same day, any losses which may have occurred in the storage period between harvesting and testing should be similar in both groups.

Zilva and Barker ('39) and Smith and Gillies ('40) demonstrated that immature potatoes have a higher vitamin C content than mature ones. Thus the advantage of late-maturing over early-matur-

ing potatoes may have been partly due to the less mature condition of the individual tubers when analyzed.

In addition, 10 (34 samples) of the late varieties were in the high vitamin-C category, and none of the early varieties was so classified. The disproportionately large number of genetically superior varieties (the interpretation of which may have been somewhat influenced by the metabolic state of the tissue) among the late tubers weighted the results in favor of late maturity.

Of the 54 varieties tested, only the 10 discussed above were early-maturing. All others were strictly comparable as regards the actual growing period.

Effect of Other Physical Characteristics

Records of eye depth, flesh color, and skin color were kept on all of the tubers analyzed. The means of the variety groups associated with these characteristics follow:

Eye Depth	Number of Varieties	Vitamin C Mg. per 100 Grams
Shallow Eyes	25	28.6 ± .68
Med. Deep Eyes	18	29.8 ± .76
Deep Eyes	9	30.8 ±1.20
Flesh Color		
White	31	29.4 ± .56
Yellow	16	28.4 ± .96
Skin Color		
White and Yellow	43	29.9 ± .53
Pink eyes and pink skin	12	26.5 ± .69

There appeared to be no association between ascorbic acid and the foregoing characteristics except possibly a negative correlation with pink eyes and pink skin. All twelve pink-eyed varieties (10 of which were pink-skinned) exhibited vitamin C values of less than 30 mg. per 100 grams.

Yellow flesh color, sometimes indicative of vitamin A development, seemed not to be associated with ascorbic acid values.

Summary

In 1942, raw new potatoes of fifty-four varieties contained ascorbic acid comparable to and sometimes in excess of field-grown tomatoes. Forty-eight of these varieties were grown in Aroostook County,

Maine. The other six varieties were produced in Orono, Maine. The tested samples included twenty-two leading commercial varieties, fourteen promising seedlings, (three of which have since been named), sixteen German varieties, and two wild varieties from South America.

The commercial varieties were found to contain from 22 to 38, the seedlings from 20 to 40, and the German varieties from 22 to 40 mg. ascorbic acid per 100 grams fresh weight. Individual tubers ranged as low as 19 and as high as 45 mg. Duplicate tests differed by 1.45 mg.; and replicate plots by 3.1 mg. Varieties were found to differ significantly from one another.

The same varieties showed significant seasonal variations in ascorbic acid content, the 1942 mean value for seven varieties being 45 per cent higher than the 1939 value for the same varieties, and 50 per cent higher than the 1938 average.

Thirteen varieties grown in two different localities had a correlation coefficient of $+ .79 \pm .07$ between localities.

There appeared to be no relationship between ascorbic acid values and size or shape of tubers, eye depth, starch content, or resistance to thirteen common diseases.

Twenty late-maturing varieties averaged $3.8 \pm .56$ mg. per 100 grams higher in ascorbic acid than ten early-maturing varieties. As the late varieties were immature when dug, the physiological age of the tissue may be responsible for the difference. Also among the late varieties there was a disproportionately large number of genetically superior varieties.

A limited number of analyses were obtained on tubers of ancestrally related varieties. Varieties high and low in ascorbic acid resulted from the same cross (Katahdin $35 \pm .37$ and Chippewa $23 \pm .20$). The highest testing seedling variety (Potomac $40 \pm .35$) came from two high parents, Katahdin and Rural New Yorker ($33 \pm .96$). There was a tendency for high parents to produce medium to high offspring, and for low parents to produce medium to low progeny.

All the pink-eyed and pink-skinned varieties, that were tested tended to be low, exhibiting values below 30 mg.

Yellow flesh color, sometimes indicative of vitamin A development, was not associated with unusual vitamin C values.

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SECTIONAL NOTES

Alabama

The potato planting season is over in South Alabama. Approximately 340 cars of seed were planted in Escambia and Baldwin counties; of this amount 305 were planted in Baldwin county. Based on seed planted, approximately 16,775 acres were planted in Baldwin county and 2,200 acres in Escambia county. Approximately 3,000 acres of this amount consisted of white varieties.

There was some delay in planting because of shortage of cars which prevented prompt delivery of fertilizers and seed. The weather was fairly favorable, although the planting season was prolonged by intermittent rains which prevent continuous planting. Temperatures have been quite high in the area and the early planted fields have come to a stand. The prolonged planting season has reduced the risk damage from cold and will result in a somewhat extended shipping season.

There probably will be a considerable amount of dusting and spraying this year to control late blight. It is seldom that this disease causes serious damage, but because of the experience of last year progressive growers are considering spraying as an insurance measure. Labor will continue to be the most serious problem for this section because of the nearness of the area to the shipyards at Mobile and along the Gulf Coast. (March 6).—L. M. Ware and Frank E. Garrett.

California

The potato situation in Kern county is about as follows at this date:

1. Ninety-eight per cent of the crop in the floor of the valley is planted.

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2. The crop planted in late November and December now has tubers from ½ to 1 inch in diameter.
3. The frost at this date has not damaged the crop even though the weather has been cold.
4. Various estimates place the acreage in the floor of the valley at 45,000 to 52,000 acres, there being 50,300 acres in 1944 in the same area.
5. The potatoes in the mountains in the Tehachapi area have not been planted as yet. Estimated plantings for this area are approximately 3,000 acres.
6. A shortage of fertilizer has caused some growers to plant their crop with less nitrogen than normally. This situation exists primarily in the Shafter-Wasco district, therefore the yield in that area may be slightly reduced.
7. Even with a shortage of fertilizer, however, weather conditions, if favorable, will make it possible to produce more potatoes in 1945 than in 1944.
8. The growers, through their Kern county Potato Growers' Association, are now cooperating with the railroads in the hopes of avoiding a car shortage in May and June. (March 9).

—M. A. LINDSAY.

* * * *

Supplies of old potatoes on the Pacific Coast are the lightest that we have ever had.

The Klamath Falls District is practically cleaned up and all eyes are now on the oncoming Kern County Deal.

The acreage is approximately the same as last year and of course the crop which will be shipped will depend largely on the weather conditions from now on.

Our territory experienced a frost on Monday morning, extending over the Shafter/Wasco/Lerdo are which will probably result in the delay of a week or ten days to those particular crops; the Edison District was not affected.

A large number of contracts for shipment, when the crops are ready, have been made and the Kern County Deal promises to be a real hot one again this year.

There appears to be a great variation in the seed potatoes used in Kern county. Some of the seed were so poor that certain acreages were replanted. There is also a shortage of fertilizer in some quarters which of course will have an effect upon the ultimate yield. (March 8).

—ERNEST MARX.

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Florida

In Dade county the harvest of 6,000 acres of potatoes planted in November is well under way. Approximately 55 per cent of this acreage was planted to the Pontiac variety which is steadily increasing in popularity in this section. The remainder of the acreage was planted to Bliss Triumphs.

Yields are the highest on record, ranging from 300 to well over 400 bushels per acre and the quality is exceptionally good. An average yield of nearly 350 bushels per acre is anticipated.

Two factors are believed to be responsible for the high yields. The first of these is the occurrence of very favorable weather early in the growing season which was responsible for a heavy set of tubers. The second factor was the use of Dithane-zinc sulfate spray on approximately 95 per cent of the acreage. The new spray prevented potato late blight from becoming epidemic and controlled early blight exceptionally well. Potato late blight was first found during the first week of January in a field where the grower had sprayed the tops four times at weekly intervals with a neutral copper. A few days later it was found in several widely scattered fields where the plants were either sprayed or dusted with copper fungicides, were imperfectly sprayed with Dithane, or were unsprayed. In spite of cool weather accompanied by considerable fogginess and several showers during January and part of February, late blight made surprisingly little headway and caused only negligible damage in fields sprayed thoroughly once a week with the new Dithane-zinc sulfate spray. The growing life of the plants was extended several weeks and a number of growers utilized successfully a solution of Sinox and ammonium sulfate to kill the tops in order to begin harvesting operations on time.

The labor situation is rather critical and combined with the high yields is expected to extend the harvesting season several weeks to a month longer than usual.

Ring rot was considerably more in evidence in the area than usual, some fields showing 5 to 8 per cent of the plants infected. *Sclerotinia sclerotiorum* (Lib.) DeBy caused appreciable damage to potato foliage for the first time. Infection ranged from a trace to 5 per cent of the foliage prematurely killed by this organism. (March 9).

—Geo. D. Ruehle.

Idaho

Approximately 29,000 cars of commercia potatoes have been shipped from Idaho at this date from the 1944 grown crop. Although this is between 2,000 and 2,500 cars less than the number shipped by the same

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date one year ago, it represents a larger percentage of the total crop. With processing plants using a large volume of potatoes and planning operations into the early summer, the potatoes available for shipment should be cleaned up fairly early. Prices have been at ceiling through the entire season and competition for the potatoes has been very keen.

The demand for seed is very good, and the certified seed crop (largest in the state's history) has been contracted earlier than usual and growers could sell large additional amounts. So far no program has been worked out to permit the sale of non-certified and "one-year-from-certification" seed other than under the table stock price order, and many growers and dealers fear a seed shortage if some adjustment is not forthcoming. O.P.A. representatives have recently held a series of meetings through the state telling growers that seed other than certified and War Approved seed must be sold under the table stock order. In several cases dealers have purchased lots eligible for War Approval, and these lots have been shipped from the state.

Under present conditions in Idaho the War Approved seed program is not the solution to seed shortages, although it will provide some additional seed in some communities. What is happening to the War Approved seed after it leaves the state is a matter for conjecture. Not long ago there appeared in a west coast newspaper under potato markets a quotation, "Certified Blue Tag U.S. No. 1, Size A." The seed originated in one of the western states.

Everybody who can get stock eligible for planting for certification or War Approval will enter one program or the other. Requests for information and application blanks are coming in every day.

The cooperative winter test plots for certified seed lots planted in San Diego County California, were considered highly successful, and plans are being made to continue this work another year. Washington, Oregon, California, Colorado, North Dakota and Idaho lots were represented in the plots this year. Plans were laid for continuation of the plots next year. (March 6). —EUGENE W. WHITMAN.

INDIANA

Early indications point to a slight reduced acreage of potatoes in Indiana this year. This is mainly due to the labor situation, for we are short-handed again. Still I believe we will have about 50,000 acres of potatoes. The home gardeners, as usual, will plant a plot and will be the larger users of good seed.

During the past few days, there has been quite a change from the Irish Cobbler to the Katahdin, Chippewa, and Sebago. Some Sequoias

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have also been grown in the state and have given excellent results. The Sebago and the Sequoia have proved most productive under our conditions,—particularly during the drought periods of 1943 and 1944. March 13).—W. B. WARD.

MICHIGAN

The potato situation in Michigan is difficult to judge or compare with other years. Shipments were moving out by way of usual channels until prices hit the ceiling. Since then, considerable movement has been through channels other than established dealers. Michigan is supposed to have a short crop, but car lot shipments are more than 1,000 cars ahead of last season at this time and it is the opinion of many that Michigan will ship more cars and trucks than were shipped last season.

The car shortage which has added much to the strength of the market to a certain extent, has eased off. Michigan has not had so many trucks active in the deal since the spring of 1942 as are operating at present.

The certified seed deal has been strong all through the season. Shipments are going out early with nearly all the available certified seed booked for the March and early April shipment.

Our labor situation is still the question mark as to the intended planting acreage. Michigan has been asked to increase its acreage compared with that of last year, but it is now very doubtful if last year's acreage can be equalled. (March 12).—H. A. REILEY.

NEBRASKA

Practically all kinds of potatoes have been exhausted in the late main crop area of Nebraska. The dealers handling table stock felt that less than 500 cars were left in the territory, including seed—and given one good week of shipping—the deal would be completed.

For better than six weeks, all potatoes, certified, table stock and otherwise, have sold at ceiling prices. There has been a brisk demand for local seed and potatoes that were intended for discard, have been regraded and sold.

The indications are for some increase in acreage, especially in certified potatoes. It is too early to determine whether the increase will also affect the table stock grower, although this is possible, in view of the excellent seed demand.

We have little information on the probable plantings in central and eastern Nebraska, where the ground is being prepared at this time for planting shortly after the first of April. Because of the serious leaf-

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hopper damage a year ago, many of the growers in that territory were discouraged, and a reduction in acreage was expected.

Although this does not pertain to the potato business, the eastern two-thirds of the state, which produced the largest corn crop in history has been in the midst of an intense campaign to save this crop, much of which was stored on the ground, and was spoiling in the last several weeks. About one hundred million bushels were involved, two-thirds of which at this writing, are reported in safe storage. If weather will continue favorable, the balance of the crop will be moved within a week or ten days. The event of warm weather would cause the corn that is still on the ground to deteriorate rapidly. (March 10).

—MARX KOEHNKE.

OHIO

The potato situation in Ohio is rather uncertain at this time, mainly because the labor problem is serious. Imported labor will no doubt be available for harvesting but growers are concerned about labor during the season.. At present it looks as if we will have a reduction in acreage below that of last year at which time it was lower than for many past years.

Our planting operations usually start the last week of March, in southern Ohio. Very little seed has been received to date. Growers naturally are concerned about our seed movement. Many of them have had word that cars are not available for loading but they see certified seed sold for table stock in retail stores. We are making an effort to get information from the growers on seed shipments which are being forwarded to the War Food Administration. (March 14).

—EARL B. TUSSING.

PENNSYLVANIA

Certified seed potatoes stored very well in Pennsylvania this year. Many growers report less loss from rot this year than during any recent year.

Nearly all growers are sold out and a considerable volume of seed has already moved to market. A shortage of seed at planting time can hardly be avoided although it is not expected that it will be as acute as it was during the spring of 1943.

Ring-rot is becoming quite serious and more widespread each year. Growers are quite alarmed over the problem that ring-rot presents, and are doing everything possible to avoid spreading the disease.

Observations made on a recent inspection trip during the week of February the 26th through the Potter county seed-growing area, re-

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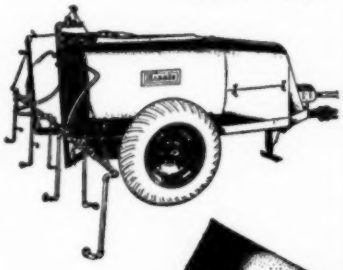

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vealed some interesting side-lights. Near Ulysses, in the heart of Pennsylvania's certified seed potato area, the snow was so deep that the ordinary equipment used in snow removal was found to be entirely inadequate. A steam shovel was used to dump the snow over the huge masses on either side of the highway and every inch of the long boom had to be used to reach over the piles.

In the same area we counted 62 deer along a 45-mile stretch of the road. During the four-day trip we saw 214 deer. Some of these deer were very thin and emaciated, whereas others were in apparently good condition, as indicated by their sleek, glossy hides. Local residents reported finding some dead deer, which probably died because of heavy snows, cold weather and lack of food. Local organizations have been feeding the deer during the critical months. (March 5).—K. W. LAUER.

SOUTH DAKOTA

Our growers are optimisitic over the potato deal for 1945 and an increase in the certified acreage is expected. In 1944, 6,900 acres were entered for certification with Bliss Triumphs as the leading variety. Our old stock is pretty well cleaned up now.

The demand is greater than the supply. Other points in the state are now looking for certified seed and it can not be obtained here. More than 900 cars have been shipped from South Dakota to date, with approximately 600 cars being certified seed. We have also had a large truck movement, not only during the fall, but also during the winter. At present we have all we need.

The annual meeting of the South Dakota Potato Growers' Association was held on the 10th of March and the meeting featured talks on the control of ring rot.

E. A. Fletcher of Garden City was re-elected president of the Association. (March 15).—JOHN NOONAN.

TEXAS

Potato growers in the Lower Rio Grande area have experienced the most disastrous epidemic of late blight on record. Unfavorable weather (for control operations) during February was largely responsible for the wide-spread losses caused by this disease. Early spring (December planted) tomatoes have also been severely damaged by blight which appears to have spread from early planted potatoes.

Growth conditions have been favorable for potatoes, and plantings which escape serious damage from blight should produce better than average yields. (March 12).—W. H. FRIEND.

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THE POTATO ASSOCIATION OF AMERICA

NEW BRUNSWICK, N. J.

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THE SEQUOIA[1] POTATO: A RECENTLY-INTRODUCED INSECT-RESISTANT VARIETY[2]

M. E. GARDNER[3] AND ROBERT SCHMIDT[4]

North Carolina Agricultural Experimental Station, Raleigh, N. C.

AND

F. J. STEVENSON,[5]

Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Research Administration, U. S. Department of Agriculture, Beltsville, Md.

ORIGIN

Sequoia, released to commercial growers in 1939, is the first variety of potato to be distributed to growers through the cooperation of the North Carolina Agricultural Experiment Station and the United States Department of Agriculture as a part of the National Potato Breeding Program. The purpose of the program in North Carolina is to develop new varieties that, because of superior yields, and disease and insect resistance, can be grown with less labor and expense than the older standard sorts.

---

[1]Sequoia (Sequoyah or Sikwayi) was a famous Cherokee Indian chief. As far as the records show he was born near Tuckaseigee in the vicinity of old Fort Louden in western North Carolina. It was for him that the giant trees in California were named in 1847. Sequoia's greatest contribution to his people was the development of an alphabet which enabled them to read and write. It is said that he spent 12 years of his life in preparing this syllabary which, according to the 19th report of the Bureau of American Ethnology, stands second to the development of our own language.

[2]Approved for publication as paper No. 200 of the Journal Series of the North Carolina Agricultural Experiment Station.

[3]Horticulturist.

[4]Associate Horticulturist.

[5]Senior Geneticist.

Parentage

Sequoia (North Carolina Seedling No. 130.5-24)	Katahdin	U.S.D.A. seedling No. 24642	Sutton's Flourball
			Aroostook Wonder
	Green Mountain	U.S.D.A. seedling No. 40568	Busola
			Rural New Yorker No. 2

Description

Plants.—Large, erect. Stems medium thick, prominently angled; nodes slightly swollen, green; internodes green; wings prominent, green; stipules medium large with scant pubescence. Leaves medium; mid-rib green, moderately pubescent upper and lower surfaces; petioles green; secondary leaflets numerous, between pairs of primary leaflets and on primary leaflet petiolules; stipules medium large, partially encircling the stem; primary leaflets medium close, elliptic-ovate, three pairs, tip of blade abruptly narrowed, obtuse, base of blade obliquely cordate, mean length 51.57 ± 0.60 mm., mean width 29.34 ± 0.37 mm.; secondary leaflets small, ovate, almost sessile. Inflorescence paniculate to cormybose, with long peduncles.

Flowers.—Pedicels rather long, pubescent; calyx lobes lanceolate, green pubescent; corolla rotate, medium large, white; stamens lemon yellow; pollen scant; style slightly bent; stigma globular, slightly lobed, green.

Tubers (Figure 1). Elliptical to oblong, thick; mean length 85.1 ± 0.80 mm.; mean width 75.1 ± 0.85 mm.; mean thickness 53.0 ± 0.49 mm.; skin smooth, dark creamy buff, slightly russeted under North Carolina conditions; eyes shallow, same color as skin; apical eye sometimes deep, more pronounced in large tubers; eyebrow medium long, curved, medium prominent; flesh white; sprouts creamy white when developed in the dark; maturity late.

Characteristics

Sequoia has been under observation and test in North Carolina since 1930. It first attracted attention because of its resistance to leafhoppers and flea beetles and its high yielding ability. Later observations showed that the vines were resistant to late blight under field conditions.

In 1932 heavy infestations of leafhoppers and flea beetles occurred in the breeding plots at Jefferson, North Carolina. Some of the seed-

[6]The authors express appreciation to: Profs. Gertrude M. Cox and J. A. Rigney for the analysis of statistical data; Dr. Ivan D. Shunk for assistance in plant descriptions; Fred N. Colvard of Jefferson, North Carolina for his splendid cooperation; and cooperators and growers in the United States, Canada, and other countries who have tested Sequoia and reported on performance in their regions.

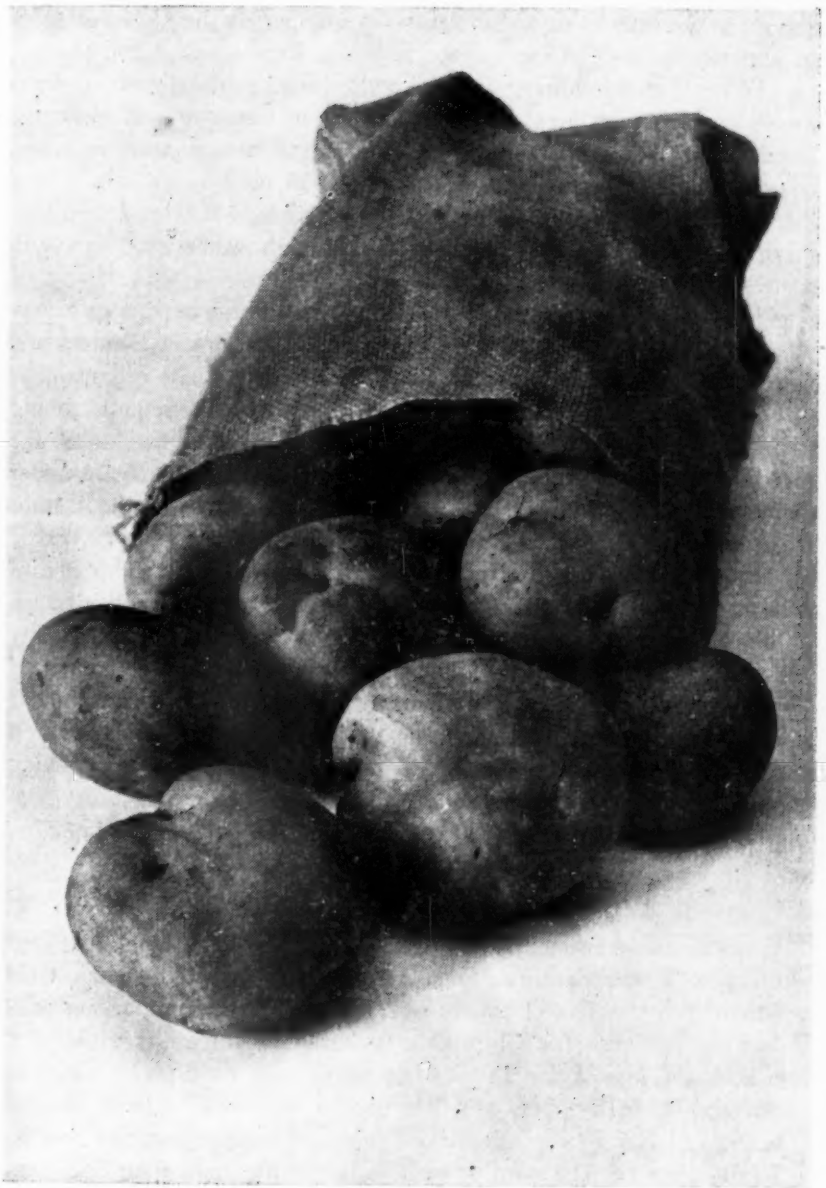

FIGURE 1. Tubers of Sequoia showing shape and depth of eye.

lings were severely injured early in the season; others seemed to be resistant to the attacks of these insects. A number of the resistant seedling varieties, among which was the Sequoia, were selected and planted in a yield test the following year. Another severe infestation of leafhoppers occurred, and again the Sequoia showed an appreciable degree of resistance. This characteristic has been noted also in tests in Ohio, Iowa, and a number of other states. In 1935 leafhopper injury was light, but a mild epidemic of late blight occurred. It was observed that the vines of Sequoia were uninjured, although other seedlings and varieties were attacked.

Vine resistance to late blight has been evident also in tests in Maryland, Pennsylvania, Maine, and other states. The tubers of Sequoia are, however, as susceptible to rot initiated by the late blight organism as are those of its Green Mountain parent. Because of this, Sequoia should be sprayed, but probably will not require as many applications as the Green Mountain. The tubers of Sequoia do not hold their shape under so wide a range of environmental conditions as do those of the Katahdin parent. This is especially true if the tubers grow too large. Some stem-end browning has occurred in Sequoia tubers, but thus far it cannot be attributed directly to net necrosis caused by the leaf roll virus.

The Sequoia, like other potato varieties, will vary in cooking quality in response to the conditions under which it is grown. It compared favorably with Green Mountain grown at Jefferson, North Carolina. It was equal to or better than the Rural at Oakland, Maryland. Grown on the Aroostook Farm, Presque Isle, Maine, it is quite high in cooking quality, although usually it is not so high in this respect as the Green Mountain. High cooking quality was also reported by New Hampshire.

Adaptation

Sequoia has consistently outyielded other varieties and seedlings at Jefferson, North Carolina. Over a nine-year period, its mean yield per acre of the U.S. No. 1 tubers was 279 bushels in comparison with 202 bushels per acre for Chippewa, its nearest competitor (table 1). Without doubt, one of the factors contributing to its superior yields is its resistance to leafhoppers and flea beetles. In 1944 Sequoia yielded 456 bushels of No. 1 tubers per acre in spite of leafhoppers, flea beetles, and blight. Flea beetles were present in larger numbers than had been observed for any season during the last fourteen years. Best results in North Carolina have been obtained on upland soils.

Sequoia has shown promise not only in North Carolina but in a number of other states. In tests at Oakland, Maryland, conducted in co-

operation with the Maryland Agricultural Experiment Station, the mean yield for a 9-year period (1936-1944, inclusive) was 363 bushels of U.S. No. 1 tubers per acre, as compared with 258 for Rural and 170 for Irish Cobbler—the two standard varieties for that district (table 2).

TABLE 1.—*Yields of Sequoia and three other varieties tested at Jefferson, North Carolina.*

Variety	Yield per Acre of U. S. No. 1 Tubers									
	1933	1934	1935	1936	1937	1938	1939	1941	1943	Mean
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Sequoia	166	307	320	184	181	301	401	280	373	279
Chippewa	157	240	226	142	181	163	208	280	223	202
Katahdin	92	175	205	137	97	133	...	243	...	155
Irish Cobbler	116	224	82	45	169	152	...	205	...	142

TABLE 2.—*Yields of Sequoia and two standard varieties tested at Oakland, Maryland.*

Variety	Yield per Acre of U. S. No. 1 Tubers									
	1936	1937	1938	1939	1940	1941	1942	1943	1944[1]	Mean
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Sequoia	200	344	420	367	342	335	465	566	225	363
Rural	150	259	224	218	205	170	344	571	182	258
Irish Cobbler	92	161	295	222	122	168	167	269	33	170

[1]Low yield caused by freezing of vines June 7, followed by drought.

At Aroostook Farm, Presque Isle, Maine, the mean yield of Sequoia for six years (1939-1944) was 382 bushels of U.S. No. 1 tubers per acre, as compared with 361 for Green Mountain, 278 for Katahdin, 321 for Chippewa, and 305 for Irish Cobbler (table 3).

TABLE 3.—*Yields of Sequoia and four standard varieties tested on the Aroostook Farm, Presque Isle, Maine.*

Variety	Yield per Acre of U. S. No. 1 Tubers						
	1939	1940	1941	1942	1943	1944	Mean
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Sequoia	224	378	415	324	639	311	382
Green Mountain	195	337	429	273	556	374	361
Katahdin	135	237	356	216	479	244	278
Chippewa	192	276	369	233	523	333	321
Irish Cobbler	185	247	381	196	517	...	305

The wide adaptation of Sequoia is further emphasized by reports of high yields from other states. It yielded well in 1942 in a number of tests in New York State on both muck and mineral soils. The chief criticism was the depth of the apical eye in large tubers. Resistance to leafhoppers and flea beetles was reported from New Jersey, the average yield being 420 bushels per acre which was higher than any other variety tested except one small plot of Chippewa which equalled this yield. The tubers of Sequoia were of good size with white skin and fairly shallow eyes. The only objection was lateness, but this was not considered serious in view of the large yields that were obtained.

Sequoia is probably too late for the early crop in South Carolina and eastern North Carolina where potatoes are harvested before maturity. In most years it is 10 days to 2 weeks later than Irish Cobbler which is the standard variety for these sections. In 1940 it outyielded nine other varieties at the South Carolina Truck Experiment Station, Charleston, and in 1942 ranked first again in yield of No. 1 potatoes. It also outyielded nine other varieties at Hastings, Florida, in 1940 and was given a skin-toughness rating of eight out of a possible ten. In 1943 Florida reported that over a 4-year period Sequoia exceeded Sebago in yield by 12 per cent and Katahdin by 41.7 per cent. The report further stated that if its marketability proves as good as its yield, Sequoia may become the leading commercial variety in the Hasting's potato section within the next three or four years.

Cultural Practices

Spacing tests in North Carolina have indicated that seed pieces should be spaced about 9 or 10 inches in the row with 3 feet or less between rows. Wide spacing and heavy fertilizing may cause the production of a large percentage of tubers that are rough and over-size. Satisfactory yields of tubers with better market quality, especially for seed purposes, have been obtained in North Carolina by using one-half (1,000) pounds of the customary amount of fertilizer, but this practice cannot be recommended generally until more tests are conducted in this and other states where Sequoia seems to be adapated.

It is suggested that growers consider these preliminary tests and adjust spacing and fertilization to suit their own conditions.

Dissemination

According to a report on the certified seed potato crop issued by the Bureau of Agricultural Economics, United States Department of Agriculture, Washington, D. C., approximately 146,372 bushels of Sequoia were certified in 1943 in eleven states. Of this quantity, North Carolina certified 33,555 bushels; Maine, 57,138; New York, 18,500; Maryland, 13,700; and Tennessee, 11,956.

Sequoia has been released for commercial production in Australia and is being tested in New Zealand and South America.

Summary

The Sequoia potato is a high-yielding, late-maturing variety that has shown marked resistance to damage caused by flea beetles and leafhoppers.

Vine resistance to late blight has been evident, but the tubers are susceptible to rot initiated by the late blight organism. Plants should be sprayed or dusted but probably will not require as intensive a program of spraying as does Green Mountain or Irish Cobbler.

Some stem-end browning has occurred under conditions in North Carolina, but thus far it cannot be attributed directly to net necrosis caused by the leaf roll virus. Greenhouse tests conducted at Raleigh may show that the browning is correlated with soil conditions.

Sequoia has responded satisfactorily to a wide range of soil and climatic conditions. In North Carolina best results have been obtained on upland soils.

Careful attention should be given to spacing and fertilizing. Because of the vigor of this variety, it produces rough, over-size tubers with a tendency to hollow heart condition, if given too much space in the row or if fertilized too heavily.

SPROUTING OF POTATOES INHIBITED BY PLANT HORMONES[1]

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INTRODUCTION

Considerable loss is commonly experienced in the spring from sprouting of potatoes in common storage, as the temperature rises.

Since artificial cold storage is usually not available, a means of inhibiting the sprouting of potatoes at temperatures above 45° F. is desirable.

Another related problem is encountered by those who manufacture potato chips. Since potatoes kept in storage below 45° F. commonly develop sufficient reducing sugar to result in undesirably dark color of the chips, the stock is commonly stored for several weeks above 70° F. before manufacturing so that a desugaring process can take place (Denny and Thornton, 1942). With potatoes which have been in storage for the winter period, this higher temperature often results in rapid sprouting. A ready means of retarding sprouting during the desugaring process would have obvious advantages.

The use of plant hormones to inhibit growth of buds on various plants has appeared in the technical literature for some years. The earlier work is reviewed by Went and Thimann (1937). Repeated experiments have demonstrated the prevention of bud growth, *e.g.*, by crown gall (Locke, Riker and Duggar, 1938) and by several growth substances (Thomas and Riker, 1943). In relation to potatoes Elmer (1936) observed that their sprouting could be inhibited by the presence of ripening apples, which among other things were giving off ethylene gas. Guthrie (1938a and b) used potassium salts of indole-acetic acid and the more effective alpha-naphthaleneacetic acid to inhibit cut pieces of potato tubers. Because of the greater, but still very low, volatility of the methyl ester of alpha-naphthaleneacetic acid, Guthrie (1939a) found it still more effective. These experiments were enlarged and extended by Guthrie (1939b), Denny *et al.* (1942) and Denny (1942). The excellent promise of this chemical treatment suggested that it should be tried under midwestern conditions with locally grown varieties.

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[1]Published with the approval of the Director of the Wisconsin Agricultural Experiment Station. These investigations were undertaken and carried forward in accord with advice from various members of the station's staff particularly T. C. Allen, R. H. Burris, H. M. Darling, G. H. Rieman, J. H. Torrie, W. E. Tottingham, and J. C Walker This work was supported in part by the Wisconsin Alumni Research Foundation.

The purposes of the present investigation were to determine which one of the several promising chemicals was suitable for use in the midwest, the best method of application, the kind of storage under which it could be employed, the time when treatments should be made, and the relative effectiveness of the treatments on several common varieties of potatoes.

Materials and Methods

The potato varieties employed primarily were Chippewa, Cobbler, Russet Rural, and Triumph. These were secured from a prominent grower in northern Wisconsin in the fall of 1943 and were placed in cold storage at 40° F. until they were treated. Supplementary and less critical trials were made with Russet Burbanks and Red Warbas.

The chemicals employed[2] were indole-acetic acid, alpha-naphthaleneacetic acid, alpha-naphthaleneacetamide, methyl ester of alpha-naphthaleneacetic acid, and sodium dichlorophenoxyacetate. When these materials were used in the form of a dust, they were dissolved in 95 per cent alcohol and were atomized into Pyrax talc, except where walnut-shell flour has been specified, while it was being agitated. The dust was allowed to dry and was then ground in a ball mill. When the chemicals were used on paper, they were dissolved in a volatile solvent which was sprayed on shredded paper and was allowed to dry. The lanolin emulsion was prepared according to the procedure recommended by Howlett (1943). The aqueous spray was made by dissolving the chemical in 95 per cent alcohol and by diluting this with water until the final product contained only 5 per cent alcohol. The chemical was not soluble in alcohol at this concentration, but by this procedure it was dispersed in a very fine milky emulsion which remained stable for several hours.

The applications of the different materials were as follows: The dusts were shaken or blown over the tubers at the rate of ½ pound per bushel. The liquids, approximately 750 cc. per bushel, were atomized over the tubers so that the entire surface was moistened. When applied in the form of a gas, the methyl ester of alpha-naphthaleneacetic acid was placed in a watch glass on a hot plate inside a closed box with the potatoes to be treated. The air was circulated by an electric fan, and the box was kept sealed for 24 hours. After treatment, the potatoes were stored in small cloth bags in a dry room slightly warmer than 70° F. Gas or vapor treatments doubtless can be improved greatly when "freon" and similar substances again become available.

[2]Some of these chemicals were kindly supplied by the American Cyanamid Company and the Dow Chemical Company, and some of the potatoes by J. D. Swan of Delavan, Wisconsin.

The results have been recorded in terms (1) of average sprout length, (2) of average sprout weight, and (3) of total weight lost. For the last two the results appear as percentages of the original tuber weights. All the experiments were set up with several replications.

Experimental Results

Comparison of Different Plant Hormones

Treatments with several different chemicals were employed at 0.2 and 0.6 per cent concentrations, respectively, in dust form on Cobbler and Triumph varieties. Each treatment on each variety had three replicates, the results of which are summarized in table 1. Treatments were made on the 10th of March, the potatoes were stored above 70° F., and final results were taken on the 21st of April. The data on sprout length, sprout weight, and total weight lost, all indicated that the methyl ester of alpha-naphthaleneacetic acid was distinctly superior to any of the

Table 1.—*The effect of various chemicals, applied in dust forms in two concentrations, upon the Cobbler and Triumph varieties.*

Chemical	Variety	Average Sprout Length		Sprout Weight		Total Weight Lost	
		0.2 Per cent Dust	0.6 Per cent Dust	0.2 Per cent Dust	0.6 Per cent Dust	0.2 Per cent Dust	0.6 Per cent Dust
		Millimeters		Per cent[1]		Per cent[1]	
α-Naphthaleneacetic acid	Cobbler	25	20	2.5	1.4	8.8	8.2
	Triumph	46	37	3.0	2.0	11.9	12.9
α-Naphthaleneacetamide	Cobbler	71	37	3.7	2.5	11.2	10.0
	Triumph	125	117	5.5	5.0	15.4	15.7
Methyl-ester of α-naphthaleneacetic acid	Cobbler	3	2	0.2	0	7.1	6.7
	Triumph	3	3	0.2	0	10.0	10.4
Sodium-dichlorophenoxyacetate	Cobbler	63	46	3.7	2.5	10.6	9.6
	Triumph	125	125	5.2	4.8	17.0	17.7
Indole acetic acid	Cobbler	34	41	3.0	2.5	9.9	10.0
	Triumph	125	117	4.8	4.5	18.1	15.1
Talc only (Check)	Cobbler	63		3.1		9.9	
	Triumph	133		5.4		17.6	

[1]As per cent of original tuber weight.

other substances used, and that the 0.2 per cent concentration was almost as good as the 0.6 per cent concentration.

The only other chemical used which inhibited the sprouting to any marked degree was alpha-naphthaleneacetic acid. Tubers treated with this chemical showed less sprouting than the checks, but the sprouting was not inhibited nearly so well as with the methyl ester of alpha-naphthaleneacetic acid, where the results on sprout length and sprout weight were obviously significant from inspection.

A statistical analysis was made of the data on total weight lost. It showed that treatments with the methyl ester of alpha-naphthaleneacetic acid were highly significant at both concentrations and on both varieties. The alpha-naphthaleneacetic acid treatment was significant at the 1 per cent level on the Triumph variety but only moderately significant (5 per cent level) at the higher concentration on the Cobbler variety.

Applications

The method of application was studied with the methyl ester of alpha-naphthaleneacetic acid applied in various forms on the Chippewa variety as indicated in table 2. The chemical was applied at the rate of 0.9 gm. (3/100 oz.) per bushel. This experiment ran from the 5th of February to the 21st of April, 1944, at a temperature above 70° F.

Table 2.—*The effect of various methods of applying the methyl ester of alpha-naphthaleneacetic acid to the Chippewa variety, 0.9 gm. per bushel.*

Method of Application	Average Sprout Length	Sprout Weight	Total Weight Lost
	Millimeters	Per cent[1]	Per cent[1]
Dusts	10	0.7	23.3
Talc	8	0.8	22.7
Walnut shell flour			
Sprays	14	1.1	25.8
5 per cent Ethyl Alcohol	8	0.6	27.2
Lanolin Emulsion			
Treated paper	5	0.4	23.8
Gas	33	3.1	25.4
No treatment	75	5.6	32.3

[1]As per cent of original tuber weight.

The results given in figure 1 are the averages of three replications. All the methods of applications used, with the exception of the gas, appeared promising. The results taken according to sprout length and sprout weight are closely parallel, and their significance was obvious by inspection. In regards to total weight loss none of the methods of application was found to be significantly better than the controls when a statistical analysis was run. The "gas treatment," in which the chemical was volatilized over a hot plate in a closed chamber, was only partially success-

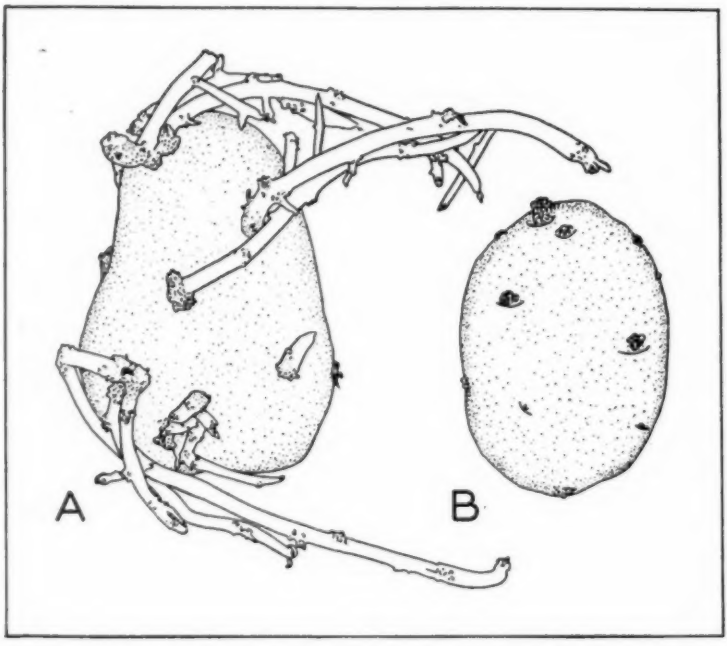

FIGURE 1.—Chippewa tubers treated with talc dust alone (A) and with dust containing 0.4 per cent methyl ester of alpha-naphthaleneacetic acid (B). The tubers were stored from February 5 to April 21 at 70° F. To show the sprouts more clearly, a drawing was made over a photograph (silvertone).

ful in inhibiting sprouting. Since the chemical can be employed successfully in liquids, dusts, or shredded paper distributed among the tubers, the method of application appears to be adaptable to individual commercial requirements.

VARIETIES

Several different varieties were treated with a dust containing the methyl ester of alpha-naphthaleneacetic acid. The treatment was made on the 12th of February, the tubers were stored above 70° F., and the

records were taken on the 24th of April. The rate of sprouting varied among the varieties, but with every variety the treatment successfully inhibited the sprout development and reduced the total weight loss, as shown in table 3. The significance of sprout length and sprout weight was obvious by inspection. A statistical analysis was made of the data on the total weight lost. Each treated variety lost less weight than its corresponding control. These results were all significant at the 1 per cent level.

TABLE 3.—*The effect of 0.4 per cent methyl ester of alpha-naphthalene-acetic acid dust upon several potato varieties.*

Variety	Treatments	Average Sprout Length	Sprout Weight	Total Weight Lost
		Millimeters	Per cent[1]	Per cent[1]
Chippewa	MEANAA dust	5	0.2	22.0
	Talc only	125	6.2	29.6
Cobbler	MEANAA dust	3	0	10.2
	Talc only	84	5.4	17.5
Russet Rural	MEANAA dust	3	0	16.1
	Talc only	44	3.6	21.9
Triumph	MEANAA dust	3	0	13.2
	Talc only	181	8.5	28.2

[1]As per cent of original tuber weight.

In a commercial potato storage house more than 20 standard 100-pound sacks of Russet Burbanks were treated on the 4th of May by distributing shredded paper among the potatoes. On the 31st of May (see figure 2) the checks had sprouts 2 to 5 inches long whereas the treated potatoes were still quite dormant and remained so until after the 1st of September. Similar treatments on the Red Warbas showed small sprouts on the 31st of May, whereas the untreated potatoes had sprouted and disintegrated to a commercially worthless condition.

TIME OF TREATMENT

The length of time the treatments were effective was studied on Chippewa potatoes. They were treated on the 5th of February, were kept in cold storage at 40° F. until the 6th of June, and then were moved to storage at about 72° F. After one month treated tubers had less sprouting than the controls, but the effect of the treatments had been largely dissipated. Such results suggested that treatments made in the

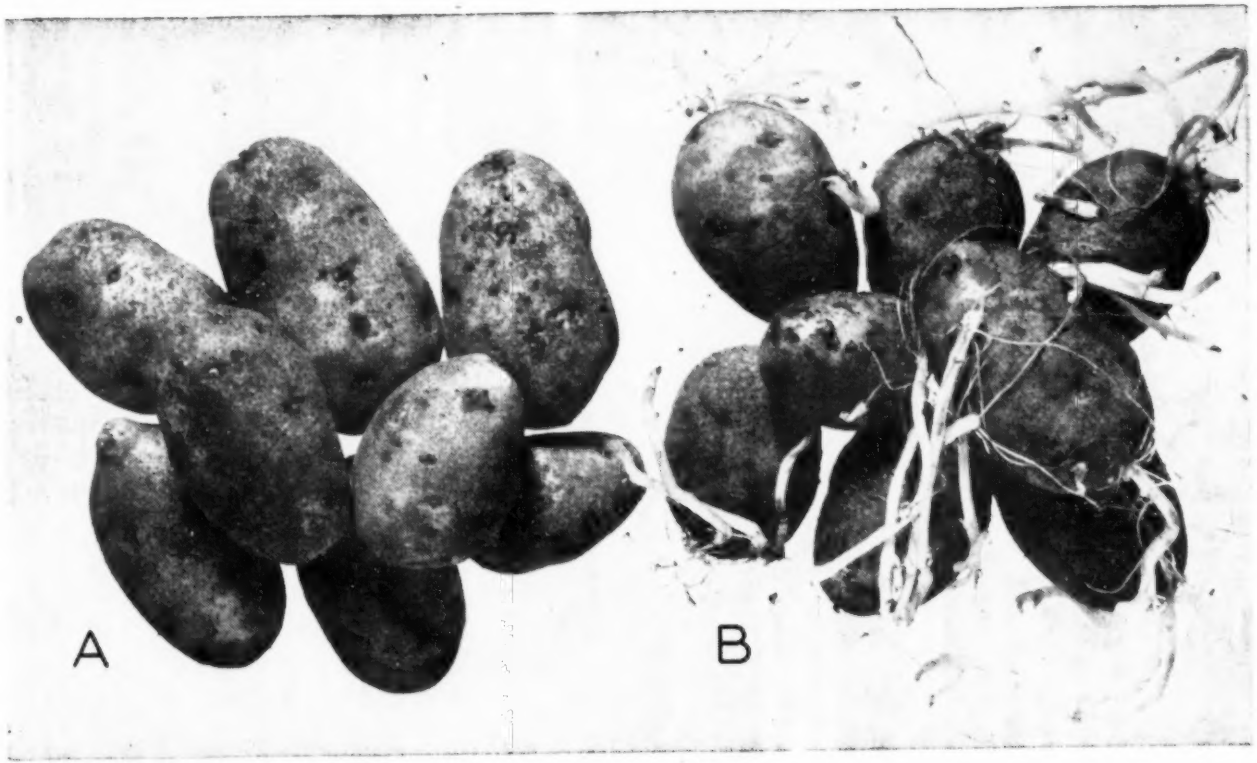

FIGURE 2.—Russet Burbank tubers stored with shredded paper carrying methyl ester of alpha naphthalencacetic acid (A) and controls without paper (B). The potatoes were treated on May 4, 1944 and photographed on June 2. By September 1 the controls had disintegrated, but the treated tubers were still sound and fit for sale.

fall would be less effective than those made in the spring shortly before the advent of warm weather. Applications of the chemical, however, should be made before the tubers break dormancy and begin to sprout. This was tried only on the Chippewa variety, and, as seen in table 3, this variety appeared to be less strongly inhibited than the other varieties used.

Injury Following Treatments

In lots treated by volatilizing the methyl ester of alpha-naphthaleneacetic acid over a hot plate, a considerable amount of breakdown and rot followed the treatment. This appeared only on the Russet Rural variety and may have been caused by an error in procedure. Triumph and Cobbler tubers given similar treatments showed no appreciable increase in the amount of breakdown and rot. Other methods of applying the methyl ester of alpha-naphthaleneacetic acid did not produce any such disturbances.

Some of the large Cobbler potatoes treated with the methyl ester of alpha-naphthaleneacetic acid developed outgrowths similar to those described by Denny (1942). These outgrowths appeared to arise from a stimulation of underlying tissues, usually in the bud area, resulting in a hard, knobby type of growth. They cracked open and blackened as they developed, but they remained hard and were not observed to rot during the time of the experiment.

Treatment and Blackening

The blackening of tubers upon boiling is often a serious problem in some regions. To see if the use of the methyl ester of alpha-naphthaleneacetic acid in treating tubers or if the inhibition of sprouting resulting from treating had any effect upon blackening, samples from every variety and every treatment were tested. These tubers were prepared, cooked, and graded in accordance with the method outlined by Rieman *et al* (1944). Neither the checks nor the treated tubers blackened upon boiling so the details are omitted. Apparently the treatment with the methyl ester of alpha-naphthaleneacetic acid and its subsequent inhibition of sprouting did not induce blackening.

Discussion

The use of plant hormones to inhibit sprouting has promise of extending the selling season of northern-grown potatoes even after the spring weather has warmed the storage bins. This would serve as an advantage both for the potato grower, who would have a longer season

in which to market his table stock, and for the consumer, who would have a longer buying season for local potatoes.

The results of these experiments are presented after only one season of trials because (1) they confirm the essential features of those reported by Denny and others and (2) because of the necessity for making available promptly any procedures that might favorably influence food supplies.

The cost of the hormone treatment has not been well worked out and will probably depend upon the demand. The closely related alpha-naphthaleneacetic acid has had considerable use as a fall spray to prevent the formation of abscission layers by apples and thus to prolong the picking season. Applied as a dust this hormone has prevented blossom drop of wax beans (Allen, Fisher, and Riker, 1943). So the potato grower will probably not be alone in his needs for such materials.

Since this hormone treatment is intended to prevent sprouts from developing, such treatments have not been considered for seed potatoes.

The amount of this chemical used was extremely small, since about 0.9 gm. (3/100 oz.) was applied per bushel. Denny (1942) reported that when the chemical was used at the rate of 2.7 gm. per bushel, after 5 months in storage, only 5 per cent was found in the tubers, and of this 5 per cent, 4 per cent was in the skin.

A few words of caution must be added concerning pathogenic bacteria and fungi that may be in stored potatoes. These microorganisms are commonly much more active in warm than in cool temperatures. Consequently, potatoes should be selected for relative freedom from decay organisms before they are treated with hormones and are kept at warm temperatures.

Details about commercial applications of these hormones remain to be worked out. However, the flexibility of the treatment suggests that there should not be too much difficulty. For example, the housewife could object to the dust on the potatoes, and for her the shredded paper treatment might have some advantages. This paper could be objectionable in the potato peeling machines used by many restaurants and institutions, but a little dust would be of no consequence. Treatment of potato sacks alone or supplementing another treatment has possibilities. Perhaps when materials like "freon" are again available, a treatment might be prepared having more promise than any other.

Summary

Sprouting of potatoes stored above 21° C. (70° F.) has been prevented for some time by treatments with the plant hormone, methyl ester of alpha-naphthaleneacetic acid.

The amount was about 0.9 gms. (3/100 oz.) per bushel.

This chemical was the best of several tried.

It could be used in various ways, but among those employed the applications with dust and with shredded paper were most promising.

The treatments were effective on all varieties used including Chippewa, Cobbler, Red Warba, Russet Burbank, Russet Rural, and Triumph.

Treatments just before the advent of warm temperatures seemed most effective.

Some of the treated large Cobbler potatoes developed hard knobby growths usually in the bud area. In extreme cases these cracked open and blackened on the surface, but did not seem to rot more readily than the normal tissue.

Decay incident to sprouting was reduced by sprout inhibition.

The hormone treatment was not found to induce blackening of the tubers when they were boiled.

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SECTIONAL NOTES

ALABAMA

Plantings in South Alabama were made during two separate periods. Those planted during the last week of January and the first week of February are growing well and the tubers are already sizing up. The stands from the early planting are good and the plants fairly vigorous. Potatoes planted from the middle of February to the last of February have not developed quite so good stands as those planted earlier, and the plants are not so vigorous.

The weather has been warm, and shipping from the early planted fields will probably begin by the 20th of April.

To date there has been no late blight reported from either Baldwin or Escambia counties. Some farmers are prepared to spray this year for blight after the experience of last year. Blight has not been an important factor in South Alabama in past years, and unless unusual weather factors favor the disease there is no special reason to believe that the experience of last year will be repeated this year. (April 7).—L. M. Ware and Frank E. Garrett.

CALIFORNIA

The acreage of potatoes in Kern County that will be harvested in the floor of the valley during the months of April, May, June, and July will be approximately 50,000 acres. There is yet to be planted the mountain potatoes which will be harvested in the fall. The acreage is expected to be about 3,000. This is about the same acreage that was grown in the floor of the valley and in the mountains last year.

We have had two frosts that have done some damage. It is estimated that from five to seven per cent of the 50,000 acres in the floor of the valley will be affected in two ways. The fields that were frosted will be from one to three weeks later in harvesting date. The yield will also be reduced, but it is too early to make much prediction. If no further frosts occur, we can expect approximately the same number of cars to be shipped in 1945 as was shipped in 1944.

The total produce shipped by truck and rail in 1944 of cars equivalent to 360 sacks was 32,141. The rail shipments from the 14th of April to the 8th of July is estimated to have been 24,568. Our peak rail shipments from Kern County in 1944 occurring from the 28th of May to the 3d of June was 3,870 cars equivalent to 62 per cent of all the rail shipments in the United States during that week.

MERCK PRODUCTS FOR THE GROWER

Corrosive Sublimate
Yellow Oxide Mercury
Hormodin (Available in powder or liquid form)

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Potatoes moving out of Kern County in 1944 amounted to more than 50 per cent of the total rail shipments in the nation from the 21st of May to the 1st of July. (April 6).—M. A. LINDSAY.

FLORIDA

Twelve thousand acres of potatoes were planted in the Hastings section this season. The percentage of the acreage planted to each variety is as follows: Sebago, 80 per cent; Katahdin, 15 per cent; Pontiac, 4 per cent and others 1 per cent. The weather was exceptionally dry during February and March as only .48 of an inch of rain fell during those two months and the potato yields have been greatly reduced in fields which were not irrigated.

Harvesting started the 28th of March but only about 100 cars have been moved to date. Shipments will not be heavy until the 16th of April or later. The quality of the crop is good.

Diseases have not been very prevalent except black leg which is always present in fields of Sebago. Late blight has not been observed in any of the fields to date. (April).—A. H. EDDINS.

IDAHO

The final report from the Office of Marketing Services, War Food Administration, shows that Idaho had shipped, up to March 28, 31,300 cars as against 34,899 on the same date in 1944 and a total of 39,006 cars for the whole 1943-'44 season. With shipments remaining to go, it looks as if Idaho will be around 5,000 cars short of last year's shipments.

Intentions to plant indicate an increase in acreage above that of last year but probably not as much acreage as in 1943, the all-time high. The biggest certified seed crop in the history of the state has all been contracted at ceiling prices. Further increases in acreage applied for, for certification, are likely if growers can get enough eligible stocks.

The winter test plots in California have done much to stress the importance of tuber unit seed plot work, and more growers will adopt this method this year. The inclusion of provisions in the Idaho Crop Improvement Association regulations for production of foundation and registered seed stocks will also provide more incentive for seed plot work in this state. Several carloads of certified Russet Burbanks from Idaho have gone into California this year.

Dehydrators will hold potatoes as long as feasible this spring and summer for late operations. (April 9).—EUGENE W. WHITMAN.

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INDIANA

Considerable plowing and ground preparation is going on at this time for the main crop of potatoes in our state. The rain in certain localities has been rather heavy, which will delay soil preparation for some time, but we are about a month ahead of last year and I believe that our potatoes will be planted in good shape. There has been a definite change in varieties in Indiana, to Katahdins and also to some Sebago, with both the White and Russet Rural and Chippewa coming back. Central and southern Indiana, which grow only a fair amount of potatoes, will plant whatever they can get, and I presume that Irish Cobbler will still be the leader although there is a definite swing again to the Sequoia for central and southern Indiana. The labor situation has not improved and we may be faced with a smaller potato acreage in '45 than last year. However, this will be determined later on. Table stock and seed potatoes are plentiful and the price is good. (April 5).—W. B. WARD.

NEW JERSEY

Approximately 95 per cent of the New Jersey potato crop has now been planted. If good weather prevails throughout this week, practically all the commercial crop will be planted by the 21st of April. This has been one of the earliest seasons on record. Because of this fact some growers are planting a larger acreage than they had originally planned it is now believed that the total acreage will be approximately the same as last year or 71,000 acres.

Although adequate labor has been difficult to obtain, growers have been able to plant their potatoes in a remarkably short time because of the excellent planting conditions.

The entire acreage has been planted under favorable soil and climatic conditions and the crop should get off to a good start if favorable growing conditions prevail.

Some of the potatoes are already emerging,—especially those that were planted at an early date, and if a killing frost does not injure the plants we should experience more extensive early harvesting than usual.

Fertilizer mixers have experienced a difficult season regarding their labor problems, but they have managed to deliver the needed fertilizer in record time. (April 16).—JOHN C. CAMPBELL.

NEW YORK

Spring came early to New York and March was remarkably mild, warm and sunny. The heavy snows which had covered the ground

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since late November disappeared into the ground with a minimum of flood damage and erosion. Much plowing was done and even a few potatoes were planted in Allegheny County in March.

Intentions of potato growers as of the 1st of March indicate an acreage increase of 1 per cent on Long Island and a decrease of 2 per cent in upstate New York as compared to 1944. More recently, there is reason to believe that the decrease in acreage will be even greater. The principal reason is labor shortage. Some growers express themselves as discouraged with the prospect of another year of exhaustive effort to produce high labor food crops with neither labor nor machinery enough to do an efficient job.

A seed shortage is developing already and many of the smaller growers have not yet placed their orders. Some dealer orders for seed have been cancelled because of difficulty in getting sufficient fertilizer. The reason for the fertilizer shortage is a shortage of labor at the fertilizer manufacturing plant. This may all add up to a still further decrease in potato acreage than that already indicated.

Planting on Long Island is no further along than normal in spite of the early spring. As of this date about two-thirds of the acreage on the Island is planted.

Upstate, there will be an increased acreage planted on muck soil because of the intention to decrease the corresponding acreage of onions. (April 7).—E. V. HARDENBURG.

OHIO

The weather in March was unseasonable and the temperature averaged 12° above normal. Potato planting started in the southern part of the state the latter part of March but heavy general rains the last of March and the first of April delayed further planting until this week. Plantings are general over the state.

Planting intentions show a 6 per cent decrease in acreage. This will mean the smallest acreage since 1866. The reduction in acreage in the state has been caused largely by the discontinuance of potato growing in small gardens and on farms for home use and small farm acreages. The potato industry in Ohio has developed in the past few years on larger acreages and there will be little change in the commercial acreage. Some few growers are cutting down whereas others are increasing. Some acreage reduction is also due to the induction into the service of young farmers who had been growing potatoes.

The acreage of Russet Rurals will be further reduced this year,—the Katahdin and the Sebago will replace most of this acreage. (April 10).—EARL B. TUSSING.

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OREGON

Present indications are that potato growers in the Klamath Basin will plant a considerable increased acreage, providing a sufficient quantity of commercial fertilizer can be secured. The War Food Program sign-up covering over 40 per cent of the farms of Klamath County shows an increase of 25 per cent in potatoes compared with 1944. It should be borne in mind that this sign-up was made when fertilizer prospects were much better than they are at present. The same situation seems to exist in the Tulalake section of the Klamath Basin.

Shipments from the 1944 crop were almost completed by the 1st of April and totaled 12,386 cars. Shipments of certified seed have been very heavy through February and March. Indications are that the acreage of certified seed will be greater in 1945. The availability of fertilizer is again affecting the total acreage planted. Shipments of certified seed are about complete to date with considerable local demand.

Near Malin, Oregon, Klamath growers have hauled between fifteen and twenty thousand tons of accumulated manure from feed lots and are applying it to 1945 potato fields. (April 10).—C. A. HENDERSON.

SOUTH DAKOTA

Potato planting will start in this area about the 16th of April. A few growers will try out their planters this week and we have reports of one hardy grower who planted potatoes west of Clark the latter part of March. Indications are that the certified acreage will be larger in South Dakota than the 6,900 acres entered for certification last year.

Several carloads of Prince Edward Island Cobblers have been secured for growers in South Dakota and foundation Bliss Triumphs have been secured from North Dakota.

All certified seed potatoes have now been sold and shipped to growers in South Dakota Potatoes which were held for seed came through the winter in very good condition with a minimum of sprouting damage.

All growers have been cautioned to check their seed stock very closely for any evidence of ring rot. Several cars of seed were rejected in the South because of ring rot. All the potatoes in these lots have been shipped out and the warehouses and machinery will be thoroughly disinfected.

Bliss Triumphs will make up the largest part of the certified seed acreage but there will be an increase in the acreage planted to Pontiacs and Red Warbas. A very small acreage of Early Ohios is expected to be entered. (April 9).—JOHN NOONAN.

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VERMONT

The 1944 crop has apparently been absorbed through normal channels. A large percentage has gone into local markets, although some carloads of certified seed have been sent to Chicago. This is believed to be the first time Vermont potatoes, seed or table stock, have gone to that or other mid-western markets.

Comparatively little rot of any kind was reported in storages. Net necrosis in Green Mountains was particularly bad. Some hitherto good seed lines have shown unexpectedly high percentages and many table stock lots failed to make U. S. No. 1 grade on account of net.

Uncertainty in locating safe foundation stock, either at home or abroad, will probably result in reduced entries for certified seed.

Although ring rot has been found in a considerable number of lots, there have been few cases where direct loss occurred. In one instance, a grower is known to have planted the same stock carrying a trace of ring rot at least three years, with as yet no destructive break-down. Since he has expressed the intention of planting it again this year, the results may be watched with much interest.

In total acreage planted it seems doubtful if the requested 14 per cent increase will be met. Our labor shortage is acute, and most growers have strained their facilities to capacity. (April 7).—HAROLD L. BAILEY.

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THE COMPARATIVE EFFECTIVENESS OF CERTAIN CUTTING-KNIFE TREATMENTS IN THE CONTROL OF RING ROT OF POTATOES[1]

W. A. KREUTZER, W. J. HENDERSON, AND GEORGE H. LANE[2]

Colorado State College of Agriculture and Mechanic Arts, Fort Collins, Colo.

INTRODUCTION

It has been fairly well established through the recent work of Starr (8) in Wyoming and studies by Glick in Colorado (2), that boiling water is the most effective means of sterilizing the power-driven rotary cutting knife in the control of ring rot of potatoes caused by *Corynebacterium sepedonicum* (Spieck and Kott.) Skapt. and Burk. However, because of the burning out of many of the electrical heating units in use within the past 2 years, and the difficulty of replacing these units because of wartime restrictions, it was considered advisable to learn more about the efficacy of certain chemical disinfectants.

Earlier work with disinfectants using the power-driven rotary knife had indicated that a 1-500 (0.2 per cent) solution of mercuric chloride was an effective knife disinfectant (4, 7). One of these studies brought out the fact that a 0.2 per cent solution of mercuric chloride was

[1]Paper No. 195, Scientific Journal Series, Colorado Agricultural Experiment Station.

[2]The writers wish to express their appreciation to Mr. W. F. McGee, In Charge of Potato Certification and Improvement, Colorado Extension Service, for his co-operation and assistance throughout the course of this work. They also desire to thank Dr. E. W. Bodine of the Emergency Plant Disease Survey, U. S. Department of Agriculture, and Dr. A. O. Simonds of the Colorado Agricultural Experiment Station, for their aid in certain phases of this study.

an effective knife disinfectant providing the solution was replaced at frequent intervals (4). Further, it was found that a gallon of 0.2 per cent mercuric chloride solution could be used safely in cutting eight sacks of clean seed potatoes, and 40 sacks of clean potatoes could be cut safely using 7 gallons of solution. When dirty potatoes were used it was found that only 25 sacks could be cut safely using a 10-gallon lot of 0.2 per cent mercuric chloride solution.

Because of the incompleteness of earlier studies it appeared desirable to retest 0.2 per cent-solution lots of mercuric chloride in the cutting of consecutive sacks of standard unwashed seed potatoes. The effectiveness of these solutions was compared with boiling water and with Santophen[3] (a mixture of ortho and para benzyl phenols).

This work was conducted on the San Luis Valley Demonstration Farm near Monte Vista, Colorado (altitude approximately 7,600 feet).

Experimental Procedures

The effectiveness of a 5-gallon lot of a 0.2 per cent solution of mercuric chloride in destroying *Corynebacterium sepedonicum* on the blade of a power-driven rotary knife was tested by cutting 35 sacks of relatively clean but unwashed Red McClure seed tubers. A similar trial was conducted using a 1-gallon lot of 0.2 per cent mercuric chloride solution in cutting 15 sacks of these tubers. The disinfecting power of the solutions was tested at each 5-gallon sack interval by halving a visibly infected tuber with the rotary knife, smearing the knife with the cut halves, and then cutting 10 seed tubers. The process of smearing was repeated every 10 tubers until 100 seed pieces which had been exposed to infection by *C. sepedonicum* were obtained. As a measure of the effectiveness of the inoculation, 50 tubers were halved in the same fashion with a contaminated but untreated knife.

To compare the mercuric chloride solutions with boiling water, two lots of 50 tubers were halved by a knife rotating in boiling water (199 ° F.). One lot was cut without contaminating the knife with ring-rot bacteria whereas the tubers of the second lot were cut and exposed to infection by smearing the knife before cutting each tuber. Tubers used for cutting test lots were obtained at random from the sacks cut throughout the test. For a control on the possibility of tuber-borne infection in the seed stock used, two to three tubers were selected at random from each sack of tubers cut until a total of 100 tubers was obtained. These tubers were held as uncut controls.

[3]Samples of Santophen 2 and Santophen 7, together with recommendations for their use, were supplied through courtesy of the Monsanto Chemical Company.

As a further amplifiation of the work, three concentrations each of Santophen 2 and Santophen 7 were tested. These chemicals were made into solutions according to the directions given by their manufacturer in 5-gallon lot concentrations of 0.05, 0.1, and 0.5 per cent. In testing a solution, the rotating blade of the knife was smeared with an infected tuber prior to halving each of 50 Red McClure tubers.

The whole tubers and cut seed pieces, totaling 20 treatments, were divided into 4 lots of 25 each. The cut seed pieces were allowed to suberize for 24 hours and then were planted by hand in a field plot consisting of four blocks containing 20 randomized plots in each block in order to eliminate the effect of soil heterogeneity. The seed pieces were planted on the 20th and 21st of May, 1944. Readings were made between the 2d and 4th of September, 1944.

In addition, the 35 sacks of tubers which were cut alternately with the test lots of treatments 1-7 inclusive (5-gallon tank, 0.2 per cent mercuric chloride) were planted in series using a power-drawn assisted-feed potato planter.[4]

Since the study necessitated the examination of nearly 2,000 plants, it was not feasible to employ the Gram-stain method throughout the test. Disease determinations, therefore, were made using the presence or absence of vine and tuber symptoms combined with the use of the field method described by Glick *et al* (3), which consists of squeezing the vine end freshly cut just above its attachment to the seed piece.[5] If the test is correctly applied, a creamy exudate is expelled from the woody region nearest the pith (primary xylem tissues) of diseased stems. Smears were made of many of these stems using Reed's rapid Gram stain (6) and the stem exudate method of diagnosis was found to be reliable.[6]

In addition to the determination of whether a plant was infected or healthy, each diseased plant was classified in one of five severity classes according to the severity of its symptoms. Arbitrary class values of 2, 4, 6, 8, and 10 were assigned, 2 being the value given the class with plants showing one or two lower leaves wilted, and 10 being the assigned value for the class in which the plants had vines withered and dried. Severity indices were obtained by multiplying the class value (a) by the number of plants in the class (b), summing the products, and dividing

[4]This additional field test was conducted under the supervision of Mr. Frank McGee.

[5]This stem-exudate test has been used successfully for the past 2 years by the Colorado Seed Certification Service.

[6]Knorr, L. Carl. 1945. Reliability of the stem-ooze test for field identification of potato ring rot. Amer. Potato Jour. 22:57-62.

TABLE 1—*Summary of results of the use of mercuric chloride solutions, solutions of Santophen, and boiling water as treatments of the rotary knife in the control of ring rot of potatoes.*

Trt. No.	Description of Treatment[1]	No. Sacks of Potatoes Cut Preceding Test Lot	Ave. Actual Plant Stand per Plot	Average Per cent of Diseased Plants		Aver. Severity Index per Diseased Plant[4]
				Actual	Transformed[3,4]	
1	$HgCl_2$ (1-500); 5 gal. tank	5	23.50	0.0	....	....
2	" " " " "	10	23.50	0.0	....	....
3	" " " " "	15	23.50	0.0	....	....
4	" " " " "	20	23.75	0.0	....	....
5	" " " " "	25	25.00	31.50	34.11	3.69
6	" " " " "	30	22.50	22.67[2]	....	....
7	" " " " "	35	23.25	41.47	40.03	3.52
8	$HgCl_2$ (1-500); 1 gal. tank	5	24.00	0.0	....	....
9	" " " " "	10	24.75	4.0	....	....
10	" " " " "	15	24.00	79.15	63.10	4.73
11	Boiling water	..	24.25	0.0	....	....
12	" " ; no inoculation	..	22.75	0.0	....	....
13	Santophen 2, 0.5 per cent	..	24.00	14.44	22.21	2.75
14	" ", 0.1 per cent	..	23.00	65.09	54.11	4.01
15	" ", 0.5 per cent	..	22.75	70.95	58.19	4.95
16	Santophen 7, 0.5 per cent	..	24.25	22.55	28.27	4.48
17	" ", 0.1 per cent	..	24.25	51.46	45.83	3.82
18	" ", 0.5 per cent	..	22.75	68.16	55.98	3.47
19	No disinfectant	..	18.00	78.83	63.10	3.71
20	Whole seed; no inoculation	..	24.25	0.0	....	....
	Diff. req. for significance 5 per cent level		2.17		9.83	0.84
	Diff. req. for significance 1 per cent level		2.89		13.28	1.13

[1]Unless otherwise indicated, all test lots were cut with a knife contaminated with *Corynebacterium sepedonicum*.

[2]Approximately 500 ml. of fresh 1-500 mercuric chloride solution were added at this point in order to raise solution level to contact the knife. The consequent drop in infection is quite apparent.

[3]Percentages converted into degrees of an angle ($\sin^2 O$) by use of Bliss' table (1, 5).

[4]Treatments with one or more zero-value plots not included in analysis of variance.

by the total number of diseased plants in the plot (T), or $< \frac{(a \times b).}{T}$

For obvious reasons no severity index could be obtained for any treatment with one or more zero-value plots.

Experimental Results

Table 1 summarizes the results obtained. Three classes of data are considered: (1) the actual average stand per treatment, (II) the average percentage of diseased plants per treatment, and (III) the average severity of attack (as measured by symptoms) per diseased plant for each treatment.

I. *Average Stand.*—The stand in treatment 19 (inoculated control) showed a highly significant[7] decrease below all other treatments. The variations in stand between treatment 20 (uninoculated whole seed), and all remaining treatments were not significant.

II. *Average Percentage of Diseased Plants.*—Where 0.2 per cent mercuric chloride in a 5-gallon tank was used, treatments nos, 1, 2, 3, and 4 (up to and including 20 sacks of potatoes cut) gave complete protection against ring rot. Following the cutting of 25 sacks, infection appeared in the test plot (31.5 per cent disease). Analysis of variance of transformed percentage data (1, 5), shows no significant difference in ring rot between the 25- and the 35-sack treatments. However, the fact that 500 ml. of 0.2 per cent mercuric chloride solution was added (see footnote 2, table 1) following the cutting of 25 sacks of potatoes, undoubtedly altered the results in 30- and 35-sack treatments. It was noted that the addition of the disinfectant to the depleted solution in the tank offered no effective protection against infection.

The employment of 0.2 per cent mercuric chloride in a 1-gallon tank gave complete protection in only one treatment, no. 8 (5 sacks cut). A slight amount of ring rot appeared after cutting 10 sacks (4 per cent disease). After cutting 15 sacks of potatoes the solution afforded no protection (79.15 per cent disease).

No ring rot appeared in plots where boiling water was used as a sterilizing agent for the cutting knife.

All solutions of Santophen 2 and Santophen 7 used were ineffective in preventing infection by *Corynebacterium sepedonicum*. However, the increases in the percentages of diseased plants were highly significant in plots where 0.1 per cent and 0.05 per cent solutions were used when compared with the percentages in plots where 0.5 per cent solutions

[7]Where "highly significant" is used it means the figure referred to is at the 1 per cent level of significance (odds 99:1). "Significant" refers to the 5 per cent level of significance (odds 19:1).

contact the knife. [3]Percentages converted into degrees of an angle ($\sin^2 O$) by use of Bliss' table (1, 5).
[4]Treatments with one or more zero-value plots not included in analysis of variance.

were used. No significant differences were observed between the effects obtained by use of equal concentrations of Santophen 2 and Santophen 7. Tubers cut when 0.5 per cent solutions were used showed marked discoloration of their cut surfaces and plants from these tubers were noticeably less vigorous than those of other treatments.

Plants grown from the 35 sacks of tubers which were cut alternately with the test lots were given careful, though not detailed, examination at the end of the growing season. Only one infected plant was found in this entire plot. The almost complete absence of disease in this planting suggests that a grower might be able to cut more sacks of clean potatoes safely than was indicated in the results obtained in the actual test trials.

III. *Average Severity of Attack per Diseased Plant.*—Since no analysis could be made using any treatment containing one or more zero-value plots, this study was limited to a comparison of ten treatments. The average severity index in treatment 10 (mercuric chloride, 1-gallon tank, 15 sacks) was significantly greater than the inoculated control (treatment 19). In the treatments using Santophen 2 as a knife disinfectant (nos. 13-15 incl.), the use of the 0.5 per cent solution resulted in significantly less severity of attack than the inoculated control (no. 19). In addition, the severity index obtained by use of the 0.5 per cent solution was highly significantly less than either of the indices resulting from the use of 0.1 per cent and 0.05 per cent solutions.

Where Santophen 7 was used this trend was reversed, the 0.5 per cent solution yielding significantly more severely diseased plants than the 0.05 per cent solution and also showing an increase in severity index approaching significance over the inoculated control (treatment 19). Although the writers cannot explain this reversal of trend, it does tend to cast doubt on any contention that severity and percentage of plants infected are positively correlated.

Summary

1. Thirty-five sacks of clean but unwashed Red McClure seed potatoes were cut using a 5-gallon tank of 0.2 per cent mercuric chloride as a disinfectant for the rotary cutting knife. Test lots were cut at 5-sack intervals after contaminating the rotary knife with *Corynebacterium sepedonicum*. Complete protection was obtained in test lots cut following the cutting of 5, 10, 15, and 20 sacks of potatoes. Ring rot appeared in the test lot after cutting 25 sacks.

Field plantings of the 35 sacks of cut seed produced plants showing only one case of infection.

2. Where 15 sacks of potatoes were cut using a 1-gallon tank of 0.2 per cent mercuric chloride solution as a knife treatment, 5 sacks were safely cut and a small amount of disease (4 per cent) appeared in test lots after cutting 10 sacks. No protection was afforded after cutting 15 sacks.

3. The use of boiling water to sterilize the cutting knife (altitude approximately 7,600 feet, boiling point 199° F.) gave perfect protection against infection.

4. Santophen 2 and Santophen 7 (commercial mixtures of ortho and para benzyl phenol) used as knife treatments in solutions of 0.5 per cent, 0.1 per cent, and 0.05 per cent, failed to prevent infection by *C. sepedonicum*. Plots planted with tubers cut using 0.05 per cent and 0.1 per cent solutions as knife disinfectants, produced highly significant increases in percentages of diseased plants when compared with plots for which the 0.5 per cent solutions were used. Discoloration of cut tuber surfaces and some reduction in plant vigor were observed following the use of the 0.5 per cent solutions.

5. An analysis of severity indices of plants in treatments in which the disease appeared in all plots failed to reveal any constant trend.

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INFLUENCE OF CERTAIN FACTORS ON SECOND GROWTH ON RUSSET BURBANK POTATOES[1]

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INTRODUCTION

The Russet Burbank variety of potato is unique in many respects. It has many excellent qualities not found in other varieties, but it is probably one of the most particular varieties in its requirements if well shaped potatoes are to be produced. One of the greatest faults of the variety is the formation of many ill-shaped and second growth tubers where environmental or soil conditions are not almost ideal.

A plant or plant part often stops growing for a period of time when environmental conditions are unfavorable. Upon resumption of growth, due to a more favorable environment, the plant part affected may become larger, and the enlargement appears as a deformity. Many such deformities are evident in Russet Burbank potatoes exhibiting second growth. Tubers may have pointed ends, constrictions at various points, dumb-bell shapes, and growth from buds resulting in knobs varying from slight bulges to six or eight ounces in size. The term "second growth" in this paper will be confined to the knob type.

Whenever one or more of these knobs of sufficient size to break off easily are formed on a tuber, they must be cut off in grading and such potatoes become U. S. 2's or culls. According to the U. S. inspection service memorandum (Volume 7, Number 4), it is "permissible to permit one smooth, clean cut, 1½ inches in diameter, caused by removal of second growth on potatoes which are sixteen ounces or larger. Smaller size potatoes may have one smooth cut in proportion to the size of the potato, but no cuts on potatoes less than ten ounces. Knobs must be removed by cutting, not broken off." Actually only a small percentage of such tubers are left in the U. S. 1 grade, and for practical purposes all such tubers may be considered as U. S. No. 2 or culls depending upon size and shape.

This second growth condition is an important factor influencing the amount of the U. S. 2 grade produced in southern Idaho. It is difficult to estimate an average percentage figure giving the true picture of the

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extent of its occurrence. The amount of such tubers produced varies greatly from field to field, year to year, and with different environments.

It is the general opinion of most growers that second growth is caused primarily by variations in moisture supply during the growing season. More specifically second growth has been assumed to be the result of high soil moisture following a period when the soil moisture was relatively low. Many growers have also observed that large single stem plants (often referred to as "bull" plants) usually have a few large tubers showing second growth. High soil temperatures and many other factors have been suggested as possible causes. This paper is a report of experiments undertaken to determine the causes and control of second growth. Complete answers have not been obtained on all phases of the problem but enough information is available to be of some help to growers in holding second growth to a minimum.

Methods

Wherever possible the experimental work reported was conducted on replicated plots, usually consisting of four single row plots of 50 plants each. The treatments were arranged in randomized blocks, but the analyses of the data have been omitted. In most cases, however, the differences are definite and consistent and it is believed the analyses are not necessary to show what may be expected in the way of second growth formation.

Results

Relationship between Number of Stems per Hill and Second Growth

Several experiments have shown that there is a definite correlation between the number of stems per hill and second growth. To eliminate variability in the experimental work, the number of stems per hill was controlled by either cutting or pulling all stems except the number desired when the plants were small. Experiments have been conducted with hills having one, two, and many stems. Without exception, hills having one stem have produced a higher percentage of second growth tubers than those having more stems, but the actual percentage produced has varied, depending on soil fertility, environmental conditions, and to a slight extent, soil moisture.

Table 1 shows the yields and second growth of hills having various stem numbers grown on two different fields in 1943. It is evident that there was more second growth on the second year potato field. However, this is not universally true, because the previous cropping history and the immediate environmental conditions influence second growth production.

TABLE 1—*Relationship between stem number, yield, grade, and amount of second growth on two fields,* 1943.

Year and Field	No. Stems per Plant	Yield		Percentage by Weight of	
		Total 100-lb. Sacks	U. S. 1 per Acre	U. S. 1	Second Growth U. S. 2
First-year red clover land	1.0	307	227	75	13.5
	2.0	338	273	81	6.2
	4.2	362	298	83	2.0
Second-year potato after alfalfa	1.0	255	127	50	19.6
	2.0	277	160	59	10.6
	4.4	314	222	70	3.1

It is also evident from table 1 that there is an inverse relationship between stem number and the percentage of second growth. As the stem number increases, the amount of second growth decreases. This amount of second growth is directly reflected in the percentage of U. S. 1 tubers produced, total yield, and yield of U. S. 1 tubers.

Second Growth as Related to Ratio of Top Weight to Tuber Number

Observations on experiments with different stem numbers per hill indicated that the formation of second growth tubers is primarily associated with a high top-tuber ratio. It has also been observed that hills containing single stems produce vines nearly as large as hills with several stems. Upon examination it was determined that single-stemmed plants in hills produce many axillary branches which become nearly as large as the main stem. On the other hand, plants in many-stem hills produce but few axillary branches and if they are produced they are small. The net result is that the actual weight of tops and probably also the leaf area on one-stem hills is about the same as that on many-stem hills.

Further observations indicated that the number of tubers per plant was fairly well correlated with stem number. That is, there are on the average approximately two or three tubers produced per stem in a hill, regardless of number of stems. For example hills with one stem would have an average of two or three tubers, whereas hills averaging four stems would have eight to twelve tubers. To obtain some definite information on this problem several experiments have been conducted and the top-tuber ratios determined. Hills having one, two, and many stems were harvested at weekly intervals during part of the season to determine when second growth started, and its relationship to the growth of tops.

It was observed early in the experimental work that the ratio between weight of tops and weight of tubers would not show the true picture of what was happening. The fewer tubers produced by one-stem hills on the same land area as many-stem hills are considerably larger than those from the many stem hills. The calculated ratios presented are those of weight of tops to number of tubers produced per hill.

The data taken on one date at about the time second growth was starting are shown in table 2. The number of tubers per stem on all hills is fairly constant although as the stem number increases, there is a tendency for the number of tubers per stem to decrease. This may be because the plants in single stem hills are larger than those in many stem hills at the time of tuber initiation.

TABLE 2—*Ratio of weight of tops to number of tubers and its relation to second growth. Data were taken on July 29, 1943, and are averages per plant.*

No. Stems	No. Tubers	Wt. Tubers	Wt. Tops	No. Second Growth Tubers	Ratio* Tops/ Tubers	Percentage Sec. Gr. Tubers
		Grams	Grams			
1.0	3.4	179.0	459.0	1.0	1.34	29.2
2.0	7.1	178.8	520.8	0.6	.74	9.5
4.3	8.0	286.3	522.2	0.3	.65	4.1

*Ratio obtained by dividing the weight of tops by the number of tubers since 100. (R = weight/ number tubers x 100).

It is readily apparent that the total top weight of one-stem hills averages nearly as much as the total top weight in hills having two or more stems. The ratio of weight of tops to the number of tubers per hill on one-stem hills is much higher than the comparable ratio resulting on hills having two or more stems. The percentage of tubers showing second growth initiation is in good agreement with the top-tuber ratio.

In another experiment an attempt was made to determine if second growth could be controlled by limiting the stem number at different stages of growth or by limiting the amount of foliage on hills having single plants. The planting was made on the 13th of May. Reduction of stem number was effected on the 24th of June and the 8th of July. Also on the 8th of July on one set of single stem hills, all axillary branches were removed from the plants. These data are shown in table 3.

TABLE 3—*Effect of limiting stem numbers and amount of foliage at different periods of growth on amount of second growth. Planted May* 13, 1943.

Date Stem Number Limited	Stem Number	Yield		PERCENTAGE		
		Total Sacks	U. S. 1 per Acre	U. S. 1	Sec. Growth U. S. 2	Other U. S. 2
June 24	1.0*PD	351	226	65	9.5	17.8
	1.0	373	219	59	23.3	5.7
	2.0	447	353	79	3.3	9.5
July 1	1.0*PD	343	176	52	15.4	24.2
	1.0	354	182	51	20.9	15.4
	2.0	421	296	70	6.6	12.2
July 8	1.0*PD	345	174	50	8.6	31.0
	1.0	327	158	48	19.9	24.0
	2.0	401	270	68	7.6	14.5
Not pruned	4.2	454	359	80	1.9	10.6
Composite Averages						
June 24		390	266	68	12.0	11.0
July 1		373	218	58	14.3	17.3
July 8		358	201	55	12.0	23.2
	1.0*PD	346	192	56	11.2	24.3
	1.0	351	186	53	21.4	15.0
	2.0	423	306	72	5.8	12.1
	4.2	454	359	80	1.9	10.6

*All one stem plants partially defoliated by removing all axillary branches on July 8.

As in other experiments the yield decreased and percentage of second growth increased as the stem number was reduced. The time of limitation of stem number had no effect on the amount of second growth. The data on partially defoliated single stem hills confirm the results of the previous experiment; that the size of tops produced in relation to the number of stems and consequently the number of tubers per hill is an important factor in the production of second growth. Removal of axillary branches on hills with single plants resulted in a marked decrease in the amount of second growth. It is important to note that this partial defoliation also resulted in a very marked increase in other U. S. No. 2 tubers. The injury caused by removing the axillary branches possibly checked the growth of both the plants and the small tubers. It is also possible that as the plants recovered, the renewed tuber growth resulted in the formation of bottle neck, dumb-bell, or other ill-shaped tubers. A large percentage of such tubers would have to be classified as U. S. No. 2 commercially. In many fields and in many years, a high percentage of such tubers is produced. This was especially true in 1943. The indications are that such tuber deformities in commercial fields are the result of a check in plant and tuber growth, and are caused by some change in the environmental factors.

Relation of Plant Spacing to Second Growth

Experiments over a period of three years have shown that there is a definite tendency towards more second growth where wide plant spacings are used as compared with narrow spacings. The difference, however, is not always large and it varies considerably with soil, season, and other factors. Results obtained from three different fields and in different years are shown in table 4.

There was no difference between the narrow and wide spacings on clover land. On second-year potato land the wide spacings resulted in the production of considerably more second growth tubers. The results of spacing experiments on first-year alfalfa land show that between spacings of 8 and 12 inches there was but little difference in second growth, but with an increase in spacing to 16 and 20 inches considerably more second growth was produced.

In other experiments there has also been some indication that the wider the row spacing the more second growth produced, but the data available are not conclusive.

Relation of Plant Stand to Second Growth

Data from experiments on seed piece handling methods show further that plant spacing may affect the production of second growth.

*All one stem plants partially defoliated by removing all axillary branches on July 8.

TABLE 4—*Relationship between plant spacings and amount of second growth. Plots planted with uniform 2-ounce seed pieces in 36-inch rows.*

Year and Soil	Plant Spacing Inches	Yield		Percentage	
		Total 100-lb. Sacks	U. S. 1 per Acre	U. S. 1	Sec. Growth U. S. 2
1943 First-year potatoes following red clover	10.5	373	305	82	2.1
	16.3	351	291	83	2.0
1943 Second-year potatoes following alfalfa	10.5	321	234	73	2.2
	16.3	306	209	68	8.3
1942 First-year potatoes following alfalfa	8.0	385	300	78	6.5
	12.0	363	293	79	7.7
	16.0	342	257	76	10.7
	20.0	337	252	74	12.4

However, these data cannot be compared directly with spacing experiments because of variability in stand uniformity. The percentage stand recorded is based in each case on an average of four plots each originally planted with 50 seed pieces. The seed pieces were all of the same size but the percentages of stand were due to various lengths of exposure to outside air temperatures immediately after cutting.

The data in table 5 show definitely that when the stand is poor the percentage of second growth tubers produced is materially increased. The total yield of plots with poor stands is markedly less than those with good stands. This, of course, is due to the fewer plants per acre. The

TABLE 5—*Relationship between stand of plant and second growth,* 1943.

Percentage Stand	Yield		Percentage	
	Total Sacks	U. S. 1	U. S. 1	Sec. Growth U. S. 2
		Per Acre		
96	310	255	82	2.3
68	266	213	80	6.4
48	216	160	74	12.5
44	212	151	71	13.2

lower yield of U. S. No. 1 is due to both fewer plants and the lower percentage of U. S. No. 1. These data emphasize the importance of doing everything possible to insure good and uniform plant stands.

Relationship of Soil Moisture to Second Growth

No consistent results have been obtained on the effect of soil moisture on second growth. Results in 1942 indicated no relationship between alternate high and low moisture and the amount of second growth. In fact, more was obtained on uniform moisture plots than on less uniform moisture plots. Experiments in 1943 gave slight indication that alternate high and low water either in the period of early tuber formation or late in the season, increased the percentage of second growth. There are good indications, however, that if water affects second growth, it is an indirect effect on soil temperature, or on other factors such as availability of nitrogen or other nutrient elements.

Discussion and Summary

Second growth, as evidenced by knob formation, in Russet Burbank potatoes causes considerable loss in quality and in yield of marketable tubers. In actual practice most tubers showing this type of second growth are graded as U. S. No. 2 or culls, depending upon the size of tuber and the size and number of knobs on a tuber.

The data presented in this paper show that several factors alone or in combination may cause various amounts of second growth. Which factor is the most important will depend upon environmental conditions such as the cropping history and fertility of the soil, soil moisture, and cultural practices. Admittedly, it is difficult if not impossible to control all factors at one time and thus it will be impossible to control second growth completely but it can be held to a minimum.

There is a definite correlation between the number of stems or plants per hill of potatoes and the percentage of second growth tubers. Within limits, the higher the stem number, the less second growth likely to be produced. Hills having three to four stems or plants ordinarily produce a minimum of second growth tubers. One-stem hills at ordinary spacing distances (12-14 inches) usually produce many second growth tubers resulting in a decrease in grade. Adequate stem numbers per hill can be obtained ordinarily by planting large seed pieces (about 2 ounces).

Second growth varies on different fields and in different years, the amount depending upon several environmental factors.

Second growth appears to be closely correlated with the ratio of top weight to the number of tubers per hill. As this ratio increases, the amount of second growth often increases and any environmental factor that tends to increase the ratio will have a tendency to increase second growth.

Experiments in which the top growth on single plant hills was reduced by removal of axillary branches, further support the theory that one of the main causes of second growth is the high ratio of top weight to number of tubers. Second growth could be reduced markedly by such limitation of top growth. The end result of top pruning was to reduce the top size and such plants had a top-tuber ratio more nearly like that of the many-stem plants.

Close plant spacing in the row often results in less second growth. Although the correct spacing for potato plants in the row varies with soil fertility, size of seed piece, and planting date, variation in one of these factors without taking the others into consideration may result in lower yields and more second growth.

Factors such as poor seed handling, or low soil moisture at planting time, which result in poor stands of plants are also usually correlated with a greater amount of second growth. Growers should do everything possible to secure good, uniform stands for highest yield and best grade of potatoes.

Present information from several experiments indicates that variation in soil moisture is relatively unimportant as a cause of second growth. Alternate high and low soil moisture may slightly increase second growth but the indications are that other factors previously discussed are more important especially in the irrigated sections of southern Idaho. Lack of adequate soil moisture or alternate high and low moisture are more likely to cause ill-shaped or rough tubers different from those exhibiting the knob type of second growth. However, production of such tubers usually markedly lowers the grade, resulting in a loss to the grower.

SECTIONAL NOTES

ALABAMA

The season in South Alabama for the commercial crop of Irish potatoes has been favorable. High yields are being obtained, and it is now expected that about 6,000 cars will be marketed from the 18,000 acres planted. This exceeds by 2,500 cars the production from 24,000 acres planted last year. The loss from blight has been considerably less than last year. Some spraying and dusting have been done.

Growers have been generally satisfied with the Sebago variety. Consequently they have planted this variety on a large scale. Yields of 100 bags per acre of No. 1 potatoes have been obtained from plantings of Sebago 80 days old.

Damage from late blight also seems to be considerably less with the Sebago than with the Triumph. (May 5)—L. M. WARE and FRANK E. GARRET.

CALIFORNIA

As of the 30th of April, the Kern County potato growers had harvested approximately 750 cars of potatoes of which about 370 cars were shipped by rail. Last year at the same date we had harvested approximately 500 cars. Our crop has been delayed because of cold weather and some frost.

It is now anticipated that we will harvest approximately 55,500 acres in 1945. The general opinion is that the yield of potatoes will be slightly less than that of last year. The average of most estimates seems to be in the neighborhood of 200 sacks per acre as compared with 214 sacks per acre last year. Reasons for the estimated lower yield involves the question of late cold spring, three light frosts, and some poor quality seed. At the present time the crop looks very good and is growing rapidly with the temperatures ranging each day above 85° for the past week. If temperatures continue warm and not too hot, we can expect the crop to develop rapidly from now on.

The general opinion is that we will have a heavier peak shipment this year than last year. Our peak daily shipments last year exceeded 800 cars. The U. S. Army in 1944 purchased slightly less than 2500 cars, and their statement at a public meeting this week indicated that they would purchase approximately 4500 cars this year. This may help the market to a certain extent.

Plans are now under way by the War Food Administration to handle a portion of the crop if and when the price drops below support price. (May 3).—M. A. LINDSAY.

The West has never experienced a potato shortage comparable to what we have here at the present time. Every one is complaining,—there are simply not enough potatoes to go around.

The shipments from Kern County, our all-important Early Potato District, to the 7th of May, 1945, are 821 cars by rail compared with 1078 cars to the same date last season; the truck shipments this year, we believe, are considerably heavier than they were at the same time last year, so from the standpoint of new potatoes the shipments are probably as heavy this season as they were last season.

Where the great difference comes about is in the fact there are simply no old potatoes whatsoever left in the west. This factor will continue to be important as the season progresses as it will take an extremely heavy volume to fill up the holes that have been dug.

The western railroads are figuring on more business for the next few months than they have had any time so far during the war; this has of course, been caused by the shift of war activities to the South Pacific.

Regarding ultimate yields in Kern County this year, it is of course too early to state, nor can we tell too much about Army, Navy, Lend Lease, etc. requirements, except that the statement has been released that compared with the 2800 cars used from that area last year, the requirements this season will approach 5000. (May 9).—ERNEST MARX.

FLORIDA

Approximately 150 potato growers and other persons interested in the production of potatoes gathered at the Everglades Experiment Station, Belle Glade, Florida, on the 24th of April. Most of the growers present came from Dade, Palm Beach and Lee counties in Florida, although a few came from other counties in Florida and even from Cuba and Texas. A representative of the North Dakota State Seed Department was present, as also were a large number of commercial agents representing national fungicide and insecticide companies.

The meeting began at 10:30 A. M. Following a few introductory remarks by Dr. R. V. Allison the group first saw the potato variety plots and heard Mr. E. C. Minnum discuss the recent results with the newer varieties such as Sebago, Sequoia, Pontiac, Chippewa and Katahdin.

Mr. Norman Hayslip discussed insecticide tests on beans and potatoes. Excellent results on the control of the potato leaf hopper affecting beans, and the garden flea hopper affecting potatoes were seen on plots sprayed with DDT and Sabadilla.

Dr. G. R. Townsend showed the field plots and discussed the work with the newer organic fungicides on potatoes and celery. Dithane and zinx-dimethyl-dithio-carbamate were seen to be highly effective fungicides for the control of the early blight diseases of potatoes and celery.

An outstanding treatment on potatoes was seen in the combination of zinc dimethyl-dithio-carbamate and DDT in the proportions of 1½-4-100 as a spray. This combination appeared to have controlled early blight better than with the fungicide alone. It also controlled all insects affecting the potatoes except aphids; and produced exceedingly vigorous vines.

The growers were shown the results of a test of dormancy-breaking treatments on potatoes. In this test the standard ethylene chlorhydrin treatment proved to be superior to the use of the dust treatments developed by Ohio State University.

A weed control demonstration was shown in which twelve herbicides were being tested for the control of weeds in relation to a virus disease project.

Following a luncheon served on the Station grounds the group was taken on a tour of nearby farms where several new potato varieties were seen. At the Fritz Stein farm the Sebago and Katahdin varieties seemed to be yielding better than the Sequoia. Fine crops of Chippewa and Pontiac potatoes were seen on the Kruse and Borchardt farms.

Digging of the spring crop has started and it is expected that the yield will be above the average for this area. Although we are still affected by a prolonged drought, there has been enough irrigation water to keep the crop growing. Aphids have developed very heavy infestations and have hastened the dying of the vines. Early blight is prevalent on old vines where spraying has stopped and late blight has appeared in a few fields where poor spray practices were followed. (April 25).—Everglades Experiment Station.

INDIANA

The indicated potato acreage for Indiana is about 50,000 acres for 1945,—providing we can still get help and spraying material. There has been a good sale of seed for the home gardens and these gardens are becoming a factor in the potato production program in our state, as

many of them are producing enough potatoes to run them through the entire year with improved storages.

During the past thirty days our temperatures have been low. Very few things, if any, have grown and the early planted potatoes are still in the ground with a few sprouts showing here and there. The flea beetle, is making an early appearance regardless of the weather, which will mean a long siege. There is also a tendency to plant more Sebago and Sequoia in Indiana than some of the other varieties because of our climatic conditions. However, the Katahdin and the Cobbler are still "tops" with most of the commercial growers.

Other news about our fruit which may be of interest to you is that we have had about 30, 32, and 36-degree temperatures for the past week or so. Our cherry and plum crops are very light. Apricots seem to be in fairly good shape. Peaches are spotted here and there. The apples so far are all right except that we have had to apply a lot of scab sprays. About one-half of the strawberry blossoms have also been killed. Having a short crop anyway, you can see the predicament we might be in as far as our fruit goes. However, we are not on the safe side as yet. Raspberries and grapes are just in the making, but with these low temperatures,—that we have been having practically every night for the last two or three weeks,—our hopes for these crops are not very high. (May 1).—W. B. WARD.

MAINE

Maine took a long step into the future with the establishment of the Maine Seed Potato Board at the 1945 session of he Legislature. The board has been set up with a revolving fund of $100,000 to eradicate, control and eliminate many of the potato diseases which seriously threaten the future of the potato industry.

Under the emergency legislative act the Seed Potato Board is empowered to produce and provide a continuous flow of better seed potatoes into the foundation seed industry of the state. In its program the board plans to provide an ever increasing supply of top grade disease-free foundation stock to the growers of the state.

The board consists of seven members with the Commissioner of Agriculture as its chairman. The remaining six members are appointed by the governor with the advice and consent of the council.

At present the board plans to produce, on a feeder farm, about 10,000 barrels of super seed stock annually, all of which will be made available only to the foundation seed growers of the state. The tests

for this super seed will be carried out at the Aroostook Farm in cooperation with the Maine Agricultural Experiment Station of the University of Maine.

The Board will start its program with the best seed available which will be put through greenhouse tests at Aroostook Farm at Presque Isle. There the spuds will be tuber-indexed and later planted in tuber units.

In addition to research in the virus diseases, the Board will go a step further by doing considerable research on the latent mosaic diseases of the potato. This work will be carried on with five different varieties including: Green Mountain, Irish Cobbler, Katahdin, Chippewa, and Sebago.

To facilitate the initial operation, Mr. W. F. Porter of the Maine Agricultural Experiment Station, a nationwide authority on potato diseases, will direct the program for at least one year. Both the Feeder and Foundation Farms will be equipped with the latest planting, cultivating, harvesting and storage equipment. Special emphasis will be placed on the storage and handling of the seed so that there will not be the slightest possibility of contamination from other seed sources. Provision will be made to utilize the improved seed stocks in Maine as they are developed. The seed will be distributed where needed and where it will do the most good for Maine growers.

The funds arising from the sale of the seed potatoes will be paid into the State Treasury in amounts annually which will in ten years defray the $100,000 appropriated by the legislature for the operation of the Maine State Potato Seed Board.

The members of the Board are: Commissioner of Agriculture Carl R. Smith; S. A. Wathen, Fort Fairfield; Guy Hewitt, Mars Hill; David Daigle, Fort Kent; Andrew Porter, Sherman Mills, Elmer J. Leland, Sangerville; Edwin Parkhurst, Presque Isle; and E. L. Newdick, head of the State Division of Plant Industry, is Secretary of the Board. May 15.)—Maine Development Commission.

Michigan

Weather conditions have been too wet and too cold. Some of the early crop has been planted, but the late crop is yet to be planted. The prospect for the acreage is below that of last year. Most of the seed potatoes have been sold and table stock is very difficult to find with most of those that still remain in storage going to the dehydrator. (May 19).—H. A. Reiley.

MISSISSIPPI

The acreage is 20 per cent less and the stand is only 85 per cent less than that of 1944. Present indications are, however, that the yield per acre will be 10 to 15 per cent larger than last year. Harvesting will start in Stone County, about the 22nd of May; in Marion and Walthall counties about the 24th and 25th; with peak movement approximately between the 1st and 10th of June. Seventy-five per cent of the potatoes grown in the state are produced in these three counties. Comparatively little blight has been reported to date. (May 8).—J. E. SNOWDEN.

NEBRASKA

Potatoes were planted in central and eastern Nebraska during the latter part of March, in the area about Gibbon and Kearney, which is the principal early-producing section of the state. Reports indicate a substantial increase in acreage as compared with a year ago.

Examination of fields in this vicinity on the first of May showed that the plants were just beginning to emerge. This extremely slow emergence was caused by the cold,, unfavorable growing conditions during the month of April. On the 3rd of April, a 12-inch snowfall blanketed the state, and again, two weeks later, a snowfall extended over most of this territory. Growers who have examined their fields declare that there is little seed piece rotting, and they expect good stands. Even at this writing, it had not warmed up materially, so that it is impossible to check on the results.

The indications are for an increase in the acreage in several of the counties in western Nebraska. This applies to both seed potatoes, as well as table stock.

Plantings in western Nebraska do not get under way until about the 10th of June. Some growers are beginning to prepare their land, and by the first of June, weather permitting, all land will be prepared for the main late crop potatoes. The soil is in good condition, as a result of the late snows, and unless something unforeseen occurs, the seed beds should be very good.

The cool weather experienced during the past month has resulted in excellent storage conditions for all farm potato warehouses. Most growers report that their seed is in excellent condition, and is just beginning to sprout. Since the planting season is only about a month away, all growers expect the seed will continue to be in excellent condition until planting time. Since May is usually the most critical month

in the storage period, this should aid greatly in the production of good stands.

Applications for certification are now being received, and the indication is that there will be a moderate increase in acreage entered for certification as compared with a year ago. That, coupled with the fact that seed is keeping very well, should mean an even greater increase than originally indicated. Growers are still worried about the tight labor situation. However, there are indications that it will loosen up before the end of the year. There are still a number of German prisoners in this area, and these have been utilized for the peak labor need on farms. The situation is also relieved by the use of Mexican Nationals and Indians from the Sioux Reservation, just over the line in South Dakota. There is a general expectation that because of the change in the war situation, the labor will be more available before fall. (May 11). —MARX KOEHNKE.

NEW JERSEY

Nearly all New Jersey potatoes are now above ground. The frost during the latter part of April did not cause any serious damage to the crop or delay its development. For the most part, the cool weather and abundant rainfall of the past three weeks have been beneficial to the crop, however some low areas have been drowned out because of excessive rainfall. Most fields have good stands and if normal growing conditions prevail throughout June, the Cobblers should be ready for harvest in July.

The 25th annual summer meeting of the New Jersey State Potato Association will be held at the LeRoy Scott farm in Cranbury on the 22nd of June. (May 16.—J. C. CAMPBELL.

NEW YORK

Apparently there will be very little acreage change in New York this year. The large commercial growers will increase a little, while many of the small growers with less than five acres will decrease. Custom spray rings of which there were about 70 last year, will play an important role in improving the quality of the crop on at least 15,000 acres. Since the report in the April Journal, very little progress in planting upstate and in growth of the crop on Long Island has been made because of cold, wet weather. The most accurate expression of conditions is stated in the following quotations from letters received within the last week.

H. H. Campbell, Nassau County Agent, Mineola, Long Island. "Heavy showers and overcast weather during most of the week retarded growth. *Fusarium rot* of seed has been observed on one farm and reported from two other farms. One farmer is replanting 50 acres of Cobblers. A survey was made of several growers during the week. From farmer reports, fusarium rot does not appear to be causing trouble on very many farms."

C. M. Wright, Field Agent, South Fork, Long Island. "Potatoes which appeared above ground a week ago have not advanced much since that time. A few growers are beginning to cultivate. Apparently Dithane will be used by quite a few farmers this year for controlling late blight. *Colorado potato beetle* adults have been reported as abundant and feeding on emerging potatoes adjacent to grain."

Nat Talmage, grower, Riverhead, Long Island. "There has probably been a slight increase in potato acreage as growers have decreased acreage of other vegetables due to labor shortage.

"Potato planting on L. I. was a little earlier than usual, and at this writing nearly all fields have grown enough so that the rows are plainly visible, and most of them have received their first cultivation. In a few low spots some of the first sprouts were killed to the surface of the ground by frosts.

"Seed supplies were ample except for Chippewa. In this variety about 80 per cent of the orders were filled. Greenhouse and southern tests showed many seed stocks to have somewhat more virus diseases than for the past several years.

"Fertilizer deliveries did not delay plantings to any serious degree, due largely to the willingness of most L. I. growers to take delivery on their fertilizer well in advance of the planting season.

"Fusarium seed rot has been quite severe in a number of fields and it has been necessary to replant several hundred acres, mostly in Hamptons. Fields grown with seed treated with yellow oxide or Semesan Bel came through in good shape."

Irving Hopkins, grower, Pittsford, Monroe County, New York.

"There has been a good demand for certified seed this year and I don't believe that the local supply was sufficient, as quite a bit has been brought outside the state by seed houses. I think the larger growers will increase their acreage slightly this year and some of the smaller ones will decrease or quit. The weather has been very wet and no planting has been done to date.

"Fertilizer has been coming in slowly and a good many have taken earlier deliveries than usual."

William Stempfle, County Agent, Bath, Steuben County, New York.

"Steuben County's acreage, both table stock and certified seed, will be increased because of new growers and larger plantings of established growers. More than the usual amount of land was plowed in the fall, and although the open March got the season off to a good start it was delayed by the continued wet and cold weather of April. It now appears that the crop will be planted about the same time as last year. Fertilizer deliveries are slow, but I suspect it will all come through in due time." (May 14).—E. V. HARDENBURG.

NEW YORK

The potato acreage in Suffolk County is again estimated to be 60,000 acres, which is about the same as 1944. The crop was planted earlier than usual and is now a week to ten days ahead of normal. If the crop makes its usual progress it will be ready to dig by the 4th of July.

About one-half of the acreage is planted to Chippewas and Cobblers, and the other one-half to Green Mountains. This is our usual habit.

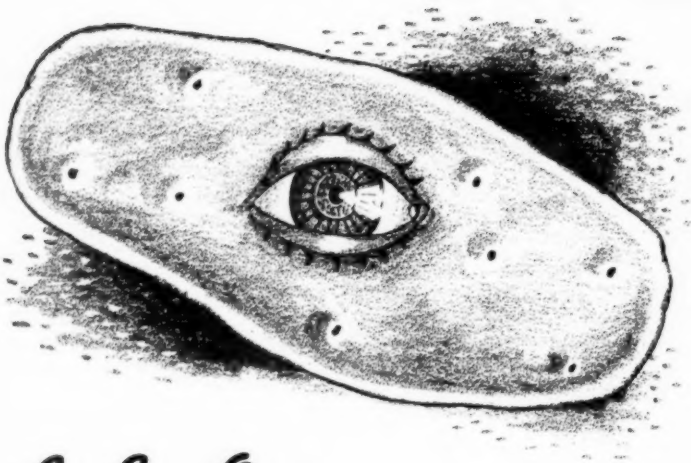
The crop is coming up good, generally. There is some complaint of severe damage from rot of seed, caused by *Fusarium*. This is not widespread, however. A greater percentage of seed has been treated this season than ever before. A two and one-half inch rainfall a week ago made the ground plenty wet after several weeks of drought. (May 3).—H. R. TALMAGE.

NORTH CAROLINA

The condition of the early potato crop of Irish Cobbler in North Carolina continues excellent. Practically all areas have received relief from the unseasonably hot dry weather that extended from planting time until the latter part of April. Although acreage has been reduced, present indications point to a total production which may exceed that of 1944. Digging will begin in some areas south of Albermarle Sound during the latter part of May and it is expected that volume movement will begin the first part of June. It usually mid-June before our heavy volume is reached.

In the western or late area, some fields have good stands. Snow fell on the 2nd, 3rd and 4th of May. Although temperatures have been rather low, frost has been prevented by rain, air movement or fog.

In this area mid-summer temperatures occurred in March, and



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naturally hastened planting operations. The danger of frost has not yet passed but if plants escape injury, potatoes will move into consuming channels from two or three weeks earlier than usual. (May 5).—M. E. GARDNER.

OHIO

April has been wet and cold. Some early planting operations took place during the latter part of March and early part of April, but few potatoes have been planted since that date. In some fields where the plants had emerged they were damaged by frost during the night of the 10th of May. Fortunately only a few potatoes were above ground, so the damage was negligible.

There was more certified seed sold in Ohio this year but that does not mean an increase in acreage. Last year many smaller growers planted their own potatoes because of the slow sales at the end of the year. This year the markets were active and growers sold their crop and purchased seed.

With labor shortage and the lateness of the season, the acreage may be reduced more than the estimated 6 per cent. (May 14).—EARL B. TUSSING.

OREGON

As of the 6th of May, nothing has happened to contradict earlier forecasts of a slight increase in Oregon's 1945 potato acreage. Last year's crop was cleaned up right to and including the bin boards and we natives have been eating our own culls, plus certified seed from here, British Columbia and North Dakota; also imported table stock from Minnesota, Maine, etc. In other words, it has been a pretty hot potato market here,—as everywhere. This year's acreage may go up some in western Oregon whereas central and eastern Oregon will hold its own or increase slightly. We have had a most backward spring throughout the entire state, but the weather is much warmer now. Because of heavy March and April snows in the mountains the irrigation water outlook is much brighter than on the 1st of March. Water in most areas should hold up well,—particularly if we get plenty of rain during May and June.

Our planting is completed in the early sections and the late irrigated regions are starting now. The western Oregon late crop won't begin until the 15th of June and the bulk will go in the ground after the 25th. It is too early, of course, to know what any of the yields will be.

The acreage entered for certification will probably increase to 5,000 this year because good seed has been moving well the last few years, that is, except for the Burbank variety. The seed market for this potato is at home and in the Stockton Delta district and we find the California buyers aren't interested in Burbanks so long as they can grow the higher yielding White Rose for the same ceiling price. (May 5.—CHESTER E. OTIS.

The lack of commercial fertilizer will undoubtedly reduce the intended potato acreage. However, the acreage planted will probably be fully as large as last year,—if not slightly larger. Interest in certified seed stock has been unusually acute throughout the whole Klamath area. Indications are that more than 12 per cent of the planted acreage will be entered for certification.

Our 1944 shipments were completed early and therefore potatoes are very scarce at the present time. Car lot shipments have now passed the 12,500 mark. The weather is very dry and the temperature is higher than normal. Growing conditions are generally good, but at present the light sandy soil types lack sufficient moisture. (May 2).—C. A. HENDERSON.

SOUTH DAKOTA

Potato planting is about 50 per cent complete at this writing (May 10). After an especially warm March, the temperatures in April were very low. Planting operations started on the 16th of April but we have been held up at different times because of cold weather and a small amount of moisture. With good weather most of the planting should be about completed in a week.

Early reports indicate an increase in the acreage to be entered for certification, but there will be a decrease in the commercial potatoes. All seed stock has now been sold and it is practically impossible to find any good potatoes for seed. Inquiries for seed are still received from other points in the state. The soil is in very good shape but good soaking rains will be needed in June.

The Bliss Triumph Variety will have the largest acreage entered for certification followed by Irish Cobblers and Pontiacs. There will be some Red Warbas entered and practically no Early Ohios.

One large grower is using the hot formaldehyde treatment for his seed, and some of the others, cold formaldehyde. The acid mercury

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is also being used by many growers. Generally speaking, the formaldehyde treatment seems to be the most successful in this area for the prevention of scab.

Plenty of help for cutting potatoes and for operating machinery in the field has been available this spring. Mexican National labor has been contracted for use in the potato harvest. (May 11). — JOHN NOONAN.

SOUTH CAROLINA

Most of our potatoes emerged early in March. The growth was so rapid during the unusually warm weather in March and early April that the crop was about three weeks ahead of normal by the 15th of April. Our prospects for a good crop are better now than for many years. However, we are aware that conditions that favor potato production also favor late blight.

On the 16th of April, blight was found in five fields, four of which had been planted partly with the White Rose seed that had a high level of blight infection in them. In one field blight had caused at least 75 per cent defoliation and 85 per cent reduction in yield. In other fields, the blight was traced to certain plants that served as foci of infection. Those plants in several instances had undecayed late blight-infected seed pieces.

We have had ideal weather for blight development and during the past month it has spread to all fields in this area. The foliage in many fields has been completely killed. For this area the estimated reduction in yield, as a result of blight on the early-planted potatoes, which comprise about 65 per cent of the crop, is approximately 25 per cent. The reduction in yield for the late-planted crop is already from 50 to 75 per cent of the crop. This reduction in yield is based on estimates of the majority of the large growers in this area, and the average loss for the entire crop as a result of blight is estimated at 33 per cent of what would have been harvested if the blight epiphytotic had not developed. Despite blight the average yield per acre is much better than it has been for several years, for the soil moisture has been optimum for the crop ever since the crop was planted.

Potato harvesting started in April,, but large scale harvesting did not start until the 7th of May, which is nearly three weeks earlier than normal. Most of the early planted potatoes will be harvested by the 25th of May. The late-planted crop will be harvested about the 1st of June if blight leaves anything to harvest.

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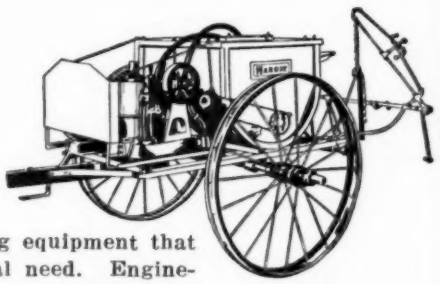

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So far the shipments of potatoes have carried O.K. in transit, but if a hot period of weather ensues in the next few weeks anything might happen to the potatoes in transit, for S.C. growers are prohibited from icing potato cars. It appears that what happened in 1943 to S.C. potatoes has already been forgotten by the I.C.C. or whoever is responsible for such orders. The potato growers are asking for no restriction on icing in case they wish to use their good judgment and ice their immature potatoes from their late blight-infected fields. Then too, the growers are asking for a higher ceiling price, but they aren't kidding themselves. They know that if anything is done in that direction it will probably come too late to do them any good, for most of the potatoes will be harvested prior to any action by the O.P.A. One week has already passed and in many cases, potatoes have been sold since the W.F.A. administrator was supposed to have notified the O.P.A. that the potato crop was being reduced one-third by blight.

There appears to be a higher percentage of the plants infected with leafroll than in other years. Sebago in some fields showed 35 per cent of the plants with blackleg. Katahdin had much less blackleg than Sebago but more than Irish Cobbler. Black leg susceptibility appears to be a serious defect of Sebago.

Ring rot has been found in one field planted with certified Katahdin seed. (May 14).—C. N. CLAYTON.

CANADA

In 1944 Canadian seed potato growers had the largest crop for a number of years,—totalling 5,600,000 bushels. Likewise excellent markets have prevailed, and it is expected that the entire supply will be disposed of. By the 21st of April the total sales were 3,752,000 bushels, with the greater part of the supplies being exported to the United States —a total of 2,528,000 bushels. Our exports to other countries totalled 827,000 bushels, and the domestic sales, 397,000.

The provinces of Prince Edward Island and New Brunswick have continued as the largest producing areas. The quality of the seed was generally high, with almost one-half of the total production in 1944 being classified as Foundation or Foundation A.

A record of the seed production in Canada last year is shown in the following table:

CANADIAN CERTIFIED SEED POTATOES, PRODUCTION IN BUSHELS, 1944 CROP BUSHELS

	FOUNDATION	FOUNDATION A	CERTIFIED	TOTAL
P.E.I.	154,800	1,320,000	1,268,500	2,743,300
Nova Scotia	6,600	74,600	49,000	130,200
New Brunswick	92,,000	700,000	1,430,000	2,222,000
Quebec	5,000	75,000	60,000	140,000
Ontario	13,000	199,000	14,000	226,000
Manitoba	100	5,800	5,400	11,300
Saskatchewan	200	2,100	600	2,900
Alberta	200	16,600	6,200	23,000
British Columbia	800	23,300	76,700	100,800
	272,700	2,416,400	2,910,400	5,599,500

(May 1).—W. N. KEENAN.

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THE CONTROL OF POTATO LATE BLIGHT TUBER ROT

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AND

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INTRODUCTION

The annual potato loss caused by late blight rot is very great. Sometimes whole bins or carload shipments are destroyed by this decay, especially in localities where the disease occurs rather infrequently and where farmers, therefore, are not familiar with it. However, some loss from late blight rot occurs every year in Maine, even though most of the farmers know the disease and the control methods.

The fungus may persist in the late blight lesions on the stalks for long periods and will produce viable spores whenever the weather conditions are favorable. Periods of cloudy and rainy weather or the presence of heavy dews are favorable for the revival of fungous growth in the infected stems and for the production of the infective conidia or spores, which are disseminated on the tubers as they pass over the digger.

A survey conducted in 1944 showed that approximately 10 per cent of the total potato crop of Aroostook County, Maine, rotted in storage because of late blight tuber rot. For 110 bins that were examined care-

[1]Associate Plant Pathologist.
[2]Principal Pathologist.

fully (1), rot varied from a trace to 75 per cent, and the average loss was 16 per cent. It has been observed in Maine that very little or no rot occurs when the potato plants are completely killed by blight early in the season. On the other hand, the amount of tuber decay may be very large when there is only a little late blight in the field, and the plants remain green until late in the season.

Tuber Rot Caused by Digging While the Foliage is Partly Green and Infected with Late Blight

Jones and Morse (2, 3, 4) state that it is best to delay digging when there is danger of rot. Murphy (5) concludes: "Evidence derived from field experiments in Canada and in Ireland is presented to show that the bulk of the infection in the case of potatoes which develops in storage is contracted when the tubers are being dug." He also states that as early as 1887 Jensen called attention to the danger of digging the crop while there was still green foliage on the diseased plants.

Large amounts of tuber rot may result when the late blight spores are continuously being washed by rain from the green foliage into the soil where they infect the potatoes before they are dug. However, it is believed that most of the tuber rot found in Aroostook County, Maine, is from infection that occurs while the crop is being harvested. The viable spores of late blight, which develop in the green stalks and leaves, come in contact with the potatoes during the process of digging, but the rot is not apparent until after the potatoes have been in storage for a week or more or have been shipped to the market.

During the season of 1941 an inspection was made of the potato bins of two growers who had experienced very severe losses in storage from late blight rot. These growers had harvested their choice seed stocks rather early in the season from fields that appeared to be relatively free from late blight and had thought the crop to be in a healthy condition. Several weeks later, however, when the bins were examined 50 to 60 per cent of the tubers were infected with late blight decay.

Further investigations revealed that similar losses were not uncommon, especially when the crop was sold on the early market, when the main crop was harvested before frost, or when seed stocks were harvested early in the season for the control of the virus diseases. In all cases it appeared that the potatoes were contaminated with spores while being dug, and that the rot was not apparent until the tubers had been in storage for several weeks.

This information led to a renewed study to determine the factors that may contribute most to the control of late blight tuber rot as it

occurs in Aroostook County, Maine. Experiments were conducted during the 3-year period 1942 to 1944 to get more definite information regarding the effect of digging the potato crop before the foliage is completely dead on the amount of tuber rot that develops in the bin.

The Green Mountain variety was used for these studies. The fields received five or six spray applications during the season, and the disease was kept under fairly good control. Some late blight, however, developed late in the season.

A part of each field was harvested each year after the middle of September when the foliage was mature and dying but still possessed some green stalks and leaves. Other parts of the same fields were harvested at later dates when the plants were completely dead, having been killed by frost. The potatoes were put into commercial bin storage immediately after being harvested and were examined for late blight tuber decay after a period of approximately 8 weeks.

The data in table 1 show that the amount of late blight tuber rot in the crop that was harvested while the foliage was green varied from 20 per cent in 1942 to 53 per cent in 1944. In contrast, the potatoes that were dug after the foliage had been killed by frost ranged from no rot in 1942 to 6 per cent in 1944. These experiments clearly confirm the contention that a great deal of late blight rot may develop if infected fields are harvested while the foliage is still green.

Unfortunately, the farmers in Maine, and probably elsewhere, continue to harvest their potato crop while the foliage is partly green and while late blight infection is present.

TABLE 1.—*Comparison of late blight tuber rot in potatoes from plots in the same field harvested before and after the foliage was killed by frost. Aroostook County, Maine.*

Treatment	Year and Amount of Tuber-Decay[1]		
	1942	1943	1944
	Per cent	Per cent	Per cent
Plots harvested before foliage was completely dead	20	48	53
Plots harvested after foliage had been killed by frost	0	4	6

[1]Average of eight 50-pound samples for each treatment after being in storage for 8 weeks.

Control of Late Blight Tuber Rot by Killing the Tops with Herbicides

Most farmers with considerable acreages of potatoes to handle, find it necessary to begin harvesting their potatoes as soon as possible in the fall and often cannot wait until the plants are dead from maturity or have been killed by frost. Some growers have found that the amount of late blight tuber decay occurring in the bin may be reduced by thoroughly spraying the potato vines just prior to digging with a concentrated copper sulphate solution. This procedure, however, does not completely kill the potato foliage which is a hindrance while the crop is being harvested. It also does not allow enough time for the skin or periderm to harden, which results in much bruising and in a poor appearance of the crop.

Experiments were conducted in 1943 and 1944 to determine whether late blight tuber rot may be controlled effectively by killing the potato tops with a chemical weed killer or herbicide before the crop is dug. The data in table 2 show that late blight tuber rot can be greatly reduced. In 1943, 40 per cent of the tubers harvested from the green plots developed storage rot, whereas only 3 per cent rotted when harvested after the plants had been killed.

Table 2.—*Effect of killing tops with a herbicide on the amount of late blight tuber rot.*

Treatment	Amount of Tuber Decay[1]	
	1943	1944
	Per cent	Per cent
Tubers dug while foliage was partly green	40.0 ± 2.8	53.0 ± 1.8
Tubers dug 2 days after tops were killed by spraying[2]	11.0 ± 1.9	13.6 ± 1.5
Tubers dug 10 days after tops were killed by spraying[2]	3.0 ± .6	3.0 ± .9
Tubers dug after tops were killed by frost	5.9 ± .9	.0 ± .0

[1]Average of eight 50-pound samples for each treatment after being in storage lockers for 6 weeks.

[2]Plants killed by spraying with 2 gallons of Sinox and 10 pounds of ammonium sulphate in 100 gallons of water.

In 1944, by killing the tops and digging 10 days later, tuber rot was reduced from 53.9 per cent to 3 per cent.

Discussion and Conclusion

Much of the late blight tuber rot that occurs in Maine is the result of harvesting the crop while the fungus is still viable and before the plants are completely dead. Many farmers do not detect the disease if it is present in small amounts on the partially dead stalks and leaves or they consider that such a small amount of blight will cause no loss. They should realize that a light infection on the foliage may cause a great deal of tuber decay in the bin. The freshly dug tubers become inoculated with the fungous spores in the process of digging the crop. The amount of tuber rot may be greatly reduced by delaying harvesting until the plants have been killed by frost.

Potato growers generally are very desirous to harvest their crop as early as possible in the fall and often do not wait until the vines are dead from natural causes. When late blight is present the potato tops should be killed by spraying with a herbicide or the harvesting should be delayed until the foliage is dead as a result of maturity or of freezing weather.

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POTATO LOADS—NEED IMPROVING

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Potatoes are grown and shipped every month of the year and are produced in commercial quantities in forty-seven states. The U. S. Department of Agriculture reports that 262,488 carloads of potatoes were shipped in 1943. This movement constitutes approximately one-third of the total movement of all fresh fruits and vegetables. The State of Maine in that same year shipped 58,756 carloads of potatoes, Idaho 31,890, and California, the third largest shipper, 29,558 cars. The states along the eastern seaboard shipped 114,149 cars.

The war has created movements to parts of the country that heretofore had never received potatoes. During the past two or three years, for example, Maine has shipped potatoes to California and Oregon, and California has shipped to many points on the East Coast. Yet, with all this heavy movement of potatoes by rail from one end of the country to the other, very few improvements had been made in the methods of packing, shipping and merchandising until just recently.

Nearly every state maintains an excellent agricultural college where thousands of dollars are spent annually instructing not only students but practical farmers in better methods of growing farm produce. Tons of literature have been prepared and sent to farmers on soil, fertilizer, improved plant production, seed treating and other phases of farm production. These schools have done an excellent job—but, unfortunately, they seem to stop at the point where the product is ready to be distributed. Some individual schools have done some work on merchandising, but very few have given much time to showing and demonstrating to the grower better methods of packing and loading the product in the car, so that it will present an attractive appearance to the buyer at destination.

The grower pays high prices to obtain the best seed possible, is very careful of the type fertilizer he uses, spends three to four months cultivating, spraying and harvesting his potatoes. Then, when the potatoes are ready to market, he will quite often pack them in old, torn, discolored bags, carry them to the railroad car and literally throw them into the car for shipment. Then, when they arrive at destination, he can't understand why such perfectly grown potatoes bring so low a price.

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[1]Representative of Association of American Railroads, Freight Container Bureau.

Much has been accomplished by the Federal-State Inspection Service since this service has been available to help the grower to help himself. The grading of potatoes and the sale of them on the merits of U. S. Standards have saved the growers millions of dollars.

Barrels, boxes, crates and bags have been and are being used to distribute this great tonnage of potatoes, but by far the largest portion is packed and shipped in bags. These bags may be made of burlap, cotton (sheeting or open mesh weave), osnaberg, woven paper fabric, or of tough kraft paper made into single or multi-wall paper bags.

The 11-peck and 150-pound burlap bags, in recent years, have been displaced by standard 100-pound bags, and this size unit today is the largest selling package for potatoes from coast to coast. Just prior to the war, consumer-size packages came into the picture in a large way, and it is expected that after the war a large portion of the shipments will be made in the 10, 15, 25 and 50-pound bags. Best results may be obtained when these bags are loaded in the cars in an orderly and careful manner.

The Freight Container Bureau, Association of American Railroads, for twenty years has been the only agency that has really studied the problem and followed a definite program of helping the growers and shippers in better methods of container use, and the loading of the product in freight cars.

This Bureau, after extensive research and tests of thousands of cars, has set up recommended standard methods of loading each type of potato package. Where these loads have been used, much food and many dollars have been saved.

Load Protection—Nearly all sections of the country shipping potatoes during the winter months require frost protection for the proper shipping of their storage potatoes. It has been the practice of most of these shippers to use heavy paper of two and three thicknesses over the floor racks. There is no doubt that the application of paper for the purpose of lining the floors and walls of cars serves a useful purpose. It certainly keeps the bags,—especially cotton bags, from becoming soiled if the floor racks or side walls of cars are dirty. Paper used in this manner on the floor racks and side walls of cars also prevents the bags from snagging or tearing because of the existing rough spots which might result from previous use of the cars. This lining also serves as an insulator and prevents heat from leaking out the car and cold air from penetrating into the car, but it has little or no cushioning value, although it has a tendency to reduce chafing. A paper lining, covering the floor racks, helps to facilitate the return of the warm air that is gen-

erated by heaters located in the bunker, after it has passed over the lading in the opposite end of the car.

It has been found through extensive study that additional protection, especially over the floor racks, is needed to prevent bruising of the potatoes and scuffing of the bags. Bedding material, such as shredded paper, loose excelsior, single or double-faced corrugated board or fabricated pads filled with excelsior or paper spread over the floor racks, will effectively prevent scuffing and bruising of the potatoes in the bottom layer as well as acting as a liner. Such protection is not only desirable for winter loads, but can be used to great advantage to prevent damage and to keep bags clean in cars loaded during all months of the year. By the use of fabricated pads placed only under the bottom-layer bags, ventilation through the load is not cut off during the summer months while the cars are en route to market.

Loading—As these shipments originate in different territories and under different climatic conditions, it follows that different methods of handling are necessary for summer and winter loading. Therefore, improved methods of loading according to the season of the year has been the goal of the Freight Container Bureau. In loading cars in summer with 100-pound bags, the Bureau recommends that the bottom layer in each stack be made up of five bags loaded upright with approximately five inches of space between every bag, with the second layer loaded crosswise on side, three rows wide, leaving about six inches of space between these bags. The third layer is loaded the same way, but only two bags wide. The load is continued solid through the doorway. Thirty stacks make up a full carload of 300 bags. With this type load there is air space around each bag in the car and no chance for the load to become disarranged or for the bags to fall out of position.

The summer load for 50-pound fabric bags is arranged so that there are seven stacks in each end of the car comprising: The first layer has 8 bags loaded upright on end, four leaning flat toward each side wall, leaving an aisle through the middle of the load; the second layer has 4 bags flat crosswise resting on top of the first layer; the third layer has wall bags flat crosswise, adjacent bags flat lengthwise, and one bag between these, bridged over aisle flat crosswise; the fourth layer is loaded the same as the second layer. The bags in the doorway should be loaded flat—crosswise of the car four rows wide, three long and three and four layers high. In order to brace the load properly at each end of the car, it is important that the doorway bags be so stowed as to fill all lengthwise space completely. The doorway bags should be set in, away

from the doors, for the purpose of avoiding chafing and to prevent the bags from falling out when the doors are opened.

If these loads are used during the summer months, many of the factors contributing toward damages and decay will be eliminated and the receivers at destination terminals will be able to realize more money for the growers' potatoes.

For shipping potatoes in 100-pound bags during the winter months, the Freight Container Bureau has developed a load that has proved successful in Maine and many of the west and central-west states.

This is a pyramid type load and every bag is loaded away from the side walls to avoid rubbing of the bags and freezing injury.

In loading the "Pyramid through Load"—start the load by placing six equally spaced upright bags at each end of the car. This is called the "Stub Stack," and causes all other bags to lean toward the ends of the car. Then load five double-stack units of 38 bags each, in each end of the car, as follows: First layer,—load six bags, four flat on floor crosswise in sets of two, in center, with one lengthwise bag at each end of these bags (but not touching the side walls); second layer—load six bags,—all flat crosswise, in sets of two; third layer, same as first, and fourth layer same as second. For the fifth and sixth layers,—load five bags, one lengthwise in center flat with two pairs crosswise on each side; and for the seventh layer, load four bags,—all flat crosswise. Ten of these double-stack units make 380 bags. The doorway bags should be two wide crosswise with three bags in bottom and second layers in each row,—four bags in third and fourth layers each row, and five bags in fifth, sixth and seventh layers, each row. This completely fills the doorway and prevents the load from shifting. By using only two rows in the doorway, bags may be placed about 12 inches away from doors, leaving plenty of room for ventilation or heating and protection from freezing.

When loading potatoes in small paper bag units, it is important that the load be definitely tilted toward the ends of the car. This is made possible with a minimum of trouble by setting up a "stub stack" at the bunkers. This will create a natural slope. Of equal importance is the placing of bags crosswise adjacent to the side walls, with the tied mouths toward the walls, and offsetting of the layers so as to keep as many bags as possible away from the car walls. This helps to eliminate wall rubbing. Except for these side-wall bags, the balance of the load should be loaded lengthwise, offset; which helps to prevent sidewise movement. The doorway bags should be loaded crosswise to hold the balance of the load in place and to avoid shifting of the load en route.

Bulletins showing diagrams and describing all these types of loads are available to growers and shippers,—free of charge. Requests for these bulletins should be made to:

Edward Dahill, Chief Engineer
Freight Container Bureau
Association of American Railroads
30 Vesey Street, New York, N. Y.

Also available to all growers and shippers at no cost are the services of the District Representatives of the Freight Container Bureau, who are ready at all times to aid in any shipping problems anywhere in the United States. In additon to the above, the Freight Container Bureau has available for public showing colored moving pictures of these loads.

There are no accurate figures available showing the amount of damage to commodities improperly loaded, but from observations at most of the Eastern Terminals, there is a woeful loss of valuable food products, and all concerned should put their shoulders to the wheel to stop.

Last shipping season the New Jersey Potato Growers estimated that they lost 1/3 of a million dollars between harvesting and markets, —some of which loss can be attributed to improperly loaded cars. Not only is this a great waste of food, which our country needs badly,—but the loss in man-hours for reconditioning and the monetary loss are also a wartime crime.

Recently, one box car of potatoes, shipped from Maine, contained 80,000 pounds. This one car of potatoes would feed 2,000 families of four for one week, or 8,000 people, averaging 10 pounds of potatoes per week per family. If 25 per cent of the potatoes in the car had arrived in New York City in a damaged condition because of poor loading, 2,000 people would not have had them to eat that week and the shippers would have lost the equivalent in money and possibly part of these people for future buyers. *PROPERLY LOADED CARS PAY DIVIDENDS.*

EFFECT OF FERTILIZERS ON THE QUALITY OF POTATOES GROWN IN THE RED RIVER VALLEY OF MINNESOTA[1]

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During the course of experimental trials with fertilizers on potatoes in the Red River Valley of Minnesota, it was considered desirable to determine the effect of these fertilizers upon their quality. The quality factors given consideration were cooking quality and dry matter contents. The properties of most importance in judging the cooking quality of potatoes are texture, cohesion, color and flavor. In general, in the United States, where boiling, steaming and baking are the most common methods of preparation, cooked potatoes with a mealy texture, a white color, and a distinctive mild potato flavor are preferred. In case of boiled and steamed potatoes very little sloughing or a high degree of cohesiveness is desired. Mealy texture or mealiness has been found to be the chief characteristic of superior quality (20, 35)[3]. Hotchkiss, Wood and Findlen (20) noted, however, that potatoes turning black when cooked caused more dissatisfaction than sogginess. The United States grades are based primarily upon size, appearance and freedom from disease and injury. More emphasis should be given to the value of potatoes for culinary use.

Potato quality is influenced by a number of environmental and nutritional factors which are discussed in considerable detail by Sweetman (35). Temperature and moisture conditions are of major importance. A number of workers (1, 3, 14, 15, 17) have shown that, in general, the lighter types of soils with sufficient clay and fine particles to give retentiveness are preferable for the production of potatoes of highest cooking quality. The literature on potato quality as influenced by fertilizers is somewhat confusing. Most experimental data show that potash fertilizers lower the mealiness or quality of potatoes, particularly when used at high rates of application (4, 15, 22, 32, 33, 35, 37). This appears to be due in large part to the potash fertilizers increasing the water content of the potatoes with the consequent result that the starch is lowered (2, 4, 5, 11, 13, 21, 22, 32, 37). For the most part sulfate of potash has been superior to muriate or kainite in increasing yields and

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[3]Figures in parenthesis refer to "Literature Cited."

maintaining quality of potatoes (2, 11, 15, 35, 37). The chloride anion has been found to be much more responsible than potassium for the reduction of the dry matter and mealiness of potatoes (2, 11, 33). Chlorides of potash have been found to cause large increases in the chlorine content of potato tubers (1, 23). A review of the literature on chlorine for plant nutrition as given by Miller (25) indicates that, in general, some chlorine is needed by plants but large amounts may be harmful, apparently causing an abnormal metabolism of carbohydrates.

Contrary to the results of most investigations, those in Rhode Island showed that potash fertilizers increased mealiness (28, 39). In Maine, Sweetman (35) reported that low rates of potash improved the cooking quality of potatoes. For soils which are relatively deficient in potash, studies in Great Britain (9, 15) and in Wisconsin (36) show that potash fertilizers are important in preventing blackening after cooking. On soils with little or no potash deficiency in Germany, Berkner and Schlimm (2) noted that muriate of potash was associated with reduced potato stands and blackening of potatoes after cooking, whereas sulfate of potash was not. Smith and Nash (32) noted that heavy applications of potash caused blackening. In a later paper (34) they concluded that differences in degree of blackening were related to the effect of fertilizer on hastening or retarding maturity. Should a fertilizer retard maturity under conditions existing in New York the potatoes would be more subject to blackening. In Germany, Berkner and Schlimm (2) noted that the potash fertilizers delayed maturity, particularly when combined with nitrogen.

Little is known about the effects of nitrogen fertilizers on quality, but there is some indication that nitrogen fertilizers tend to lower quality or dry matter content (2, 8, 24). In Colorado, Headden (19) found that high or excessive nitrates as may occur under natural conditions are harmful to quality. When nitrogen fertilizers are supplied so as to make the nitrogen level in the soil high as compared with phosphate and potash, the nitrogen fertilizers have been observed to cause significant reductions in potato quality (9, 10, 15, 27). Phosphate fertilizers have tended to increase the specific gravity and mealiness of potato tubers (5, 10, 15, 16, 22, 24).

Blood and Haddock (5) concluded, from their data, that cooking quality may be maintained without sacrificing yield when the proper ratio of plant food elements are present for the potato plants. The work of others (9, 10, 13, 15, 16, 24, 32, 35, 38) also shows that the use of properly balanced fertilizers will either maintain quality satisfactorily or improve the quality of potatoes.

Materials and Methods

For the quality tests on potatoes from the Red River Valley tuber lots were taken from 30 field experiments in 1942 and 1943. These were grown on two groups of soils, one group being relatively heavy in texture and the other light. The heavy textured group included Fargo clay, Fargo silty clay and Bearden silt loam, whereas the light-textured group comprised Bearden loam, grimstad fine sandy loam and Ulen loamy sand. With the exception of some of the lighter soils, plant tissue and soil tests showed that the soils are from medium to high in nitrates, and so nitrogen fertilizers were not used in the experiments. For the phosphate treatment 43 per cent superphosphate was applied with the planter beside the rows at the regular rate varying from 100 to 125 pounds per acre. Muriate of potash (60 per cent K_2O) and manure salts (31 per cent K_2O) were used as the potash fertilizers and were broadcast at a rate equivalent to 200 pounds of KCl per acre.

Boiling and baking tests were used as measures of cooking quality. For both boiling and baking tests five potatoes were selected from a lot of approximately 40 pounds which had been taken from the field. In 1943 the cooking tests were run in duplicate on each lot. The potatoes with jackets were boiled in unsalted water in galvanized iron vats to an internal temperature of 97.5° C. Each vat held six samples of potatoes on wires in separate compartments. The metal of the vats did not influence the color and flavor of the potatoes. After boiling, the potatoes were drained, transferred to pans, and cut in half to allow steam to escape. Portions of each potato were taken from a half with a spoon and thoroughly mixed with a fork. The samples were then scored by four judges according to the score card shown below. It was necessary to judge the potato samples immediately after preparation while still warm, for upon cooling they became less mealy and darkened slightly. Both the mashed potato and the cut surface of potato halves were observed in judging color. The score card is the same as that used by the Division of Home Economics at this station for judging the baking qualities of varieties and strains of potatoes with the exception that there are more numerical subdivisions. The same score card was used for boiled and baked potatoes. The potatoes were baked in an oven at 400° F. until an internal temperature of 100° C was reached. They were then scored by two judges. High quality Cobbler potatoes were used as a standard of comparison.

Samples for the dry matter determinations were obtained by cutting longitudinal and transverse sections from 20 tubers to give a fresh weight of 500 grams. Duplicate samples from each lot were dried at

Potato Quality Grading Card

	DESCRIPTION AND NUMERICAL SCORE*								
Quality	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Color		Very dark		Dark		Yellow or gray		Cream or white
Mealiness		Very soggy or very waxy		Soggy or waxy		Slightly mealy		Mealy
Flavor		Strong		Slightly strong		Bland or flat		Mild

*On the score sheet record numbers which give your opinion of each quality.

about 60° C. in an oven provided with a fan and then dried to constant weight in an electric oven at 95-100° C. Surface sloughing was obtained for boiled potatoes. One pound of uniform potato tubers was peeled and boiled to an internal temperature of 97.5° C. in 1 liter of distilled water in two-liter beakers. The cooked potatoes were scored for surface sloughing as follows: 1-none, 2-slight, 3-medium and 4-extreme. For potatoes of the Cobbler variety in 1943 estimates of salt content in the dried potatoes and in the cooking water were obtained by means of a modified wheatstone bridge.

Standard statistical methods were used in analyzing the data of the cooking tests and dry matter determinations.

Results and Discussion

Statistical Analysis

Quality in potatoes is difficult to determine because of the subjective nature of standards of evaluation employed. Human tastes vary, and different people have varying conceptions of standards of mealiness, color and flavor. Even with these handicaps judges of cooked potatoes have been able to detect distinct quality differences between varieties and between various environmental factors influencing quality (6, 8, 26, 32, 35). In preliminary tests the judges practiced on detecting degrees of mealiness, color, and flavor among samples which differed in these qualities. As was expected even with practice the judges continued to show some variation in opinion in regard to the numerical measure of the different quality factors and particularly mealiness.

Statistical analyses of the data from the cooking tests are given in table 1. For the boiling tests in 1943 in particular, there were significant differences between the opinions of the judges. When averages from a group of judges are used, it is not so important that the judges have the same scores as it is that the judges hold to relatively consistent differences among themselves. If one judge scores potato samples more strictly than another, this difference should be relatively consistent for all samples. It is important that each judge be capable of rating duplicate potato samples from a given lot about the same. In these cooking tests each judge rated duplicates about the same and this is indicated by the comparatively low variances for the duplicate error. As was expected the error of judges was in most cases higher than the error of duplicates. The variance for error of judges, however, is low enough to indicate that the judges were holding to fairly uniform differences among themselves in scoring the samples. The error of judges is the

TABLE 1—*Statistical analyses of the data from cooking tests which were conducted on potatoes grown at thirty different locations in the Red River Valley with different fertilizer treatments in* 1942 *and* 1943.

Source of Variation	1942			1943									
	Degrees of Freedom	Variance of Score		Degrees of Freedom	Boiled Variance for				Degrees of Freedom	Baked Variance for			
		Boiled	Baked		Color	Mealiness	Flavor	Score		Color	Mealiness	Flavor	Score
Judges	1	1.508	0.009	3	4.210**	9.277**	0.579**	6.150**	1	0.270*	0.256	0.413*	0.378
Locations	13	6.553**	10.644**	15	3.772**	8.309**	2.551**	26.117**	15	2.080**	3.027**	1.997**	15.265**
Treatments	3	2.794*	6.342**	4	0.283	0.300	0.243	1.868	4	0.588**	0.725**	1.022**	6.678**
Locations x treatments	39	1.282	1.490**	60	0.196	0.278	0.207	1.082	60	0.183**	0.145**	0.123	0.849**
Error	55	0.818	0.609	237	0.159x	0.252x	0.213x	0.830x	79	0.039	0.066	0.094x	0.285
Error of duplicates	..	...	...	320	0.027	0.084	0.123	0.336	160	0.052	0.066	0.055	0.234

*Significant at the 5 per cent level.
**Significant at the 1 per cent level.

Error of judges is used as the measure of experimental error.
xSignificantly higher than error of duplicates.

proper measure of experimental error and is used to determine whether there were significant differences between judges, treatments and locations.

The statistical analyses in table 1 show that there were wide differences in the cooking quality of potatoes from different locations. Mostly Irish Cobbler and Triumph potatoes were grown at the different locations. Differences between varieties did not contribute greatly to the differences between locations. The treatments caused some differences in quality and particularly when the potatoes were baked. It will be noted that in the baking tests the interaction between locations and treatments was significant. This is because the quality response to fertilizers was more prominent on the light soils than on the heavy soils.

Cooking Tests

The results of the cooking tests on potatoes from 30 different locations in 1942 and 1943 are given in table 2. It will be noted that the fertilizers were associated with significant response in potato cooking quality on the light textured soils but not on the heavy textured soils. In both years on the heavy textured soils the fertilizers did appear to cause slight increases in boiling and baking quality. For the light textured soils the phosphate treatment improved the boiling quality of the potatoes in 1942 but not in 1943. Both the phosphate and potash treatments improved the baking quality of the potatoes from light textured soils in 1942 and 1943. In regard to the different quality factors, color appeared to be more independent of mealiness than flavor. In general, with varietal effects excluded, the more mealy potatoes were those which also rated higher in color. It has frequently been noted that mealiness is correlated with color and flavor (3, 6, 8, 18, 35). In New York, Nash (26) observed an inverse relation between mealiness and blackening after cooking. Potatoes which matured late in New York under conditions of low light intensity were found to be more subject to blackening after cooking. The lower temperatures under these conditions appear to enhance mealiness.

It is believed that the improvements in quality observed are due in part to the added plant nutrients and in part to the higher salt content of the potatoes from the fertilized plots. Yield studies conducted by Rost, Kramer and McCall (30) and chemical tests on the potato tissues indicated that the light soils were definitely deficient in potash whereas most of the heavy soils were only slightly deficient. Both groups of soils were benefited by phosphate fertilization. The control potatoes

TABLE 2—*Influence of fertilizers on the cooking quality of potatoes grown at thirty different locations in the Red River Valley in 1942 and 1943.*

Soil Treatment	1942		1943							
	Score		Boiled				Baked			
	Boiled	Baked	Color	Mealiness	Flavor	Score	Color	Mealiness	Flavor	Score
			Heavy Textured Soils							
O	9.75	8.75	3.13	2.54	2.91	8.58	3.50	2.63	2.69	8.82
P	9.92	8.58	3.30	2.71	3.00	9.01	3.44	2.63	2.80	8.87
K — Muriate			3.28	2.73	3.01	9.02	3.47	2.74	2.80	9.01
PK — Muriate	10.17	8.92	3.28	2.79	3.05	9.12	3.58	2.75	2.94	9.27
PK — Manure salts	10.00	9.17	3.35	2.78	3.01	9.14	3.56	2.82	2.94	9.32
			Light Textured Soils							
O	8.81	8.13	3.01	2.73	2.93	8.67	2.81	2.61	2.74	8.16
P	9.75*	8.69	2.98	2.67	2.80	8.45	3.06*	2.77	2.75	8.58
K — Muriate			3.09	2.64	2.83	8.56	3.02*	2.77	2.83	8.62
PK — Muriate	9.63*	8.94*	3.03	2.68	2.94	8.65	3.13*	2.79	2.85	8.77*
PK — Manure salts	9.75*	9.75*	3.08	2.69	2.99	8.76	3.24*	3.00*	3.14*	9.38*

*Significant increase or decrease as compared to the no treatment.

In 1942 the values given are averages for 6 heavy soils and 8 light soils. In 1943 the values given for both heavy and light soils are averages for ratings from 8 fields. The cooking scores are equal to the sum of ratings for color, mealiness and flavor, the maximum score being 12.

from the light soils were somewhat lower in quality than the control potatoes from the heavy soils. Because of the general lower level of fertility in the light soils than in the heavy soils, responses to fertilization in both yield and quality of potatoes would be more likely to occur on the light soils than on the heavy soils. This proved to be the case. After fertilization the potatoes from both soil groups averaged about the same in quality.

The increase in baking quality was most prominent where the manure salts treatment for potatoes grown on the light soils was used. As compared with the control, baked potatoes from the manure salts treatment were whiter in color and held their color longer upon cooling. Unit particles of the cooked potato were smaller and tended to separate out more, giving a higher average rating for mealiness. Flavor was improved, for the potatoes tasted as though they had been salted even though no salt had been added. The content of salt in the potatoes from the different treatments is given in table 3. The potash fertilizers and particularly the manure salts increased the total salt content appreciably. MacGregor and Rost (23) found that soil fertilization with potash salts containing chlorides increased the chloride content of potatoes grown in this area by more than three times. The increase was slightly greater on the light soils than on the heavy soils.

Average results for surface sloughing in Irish Cobbler potatoes from 14 fields are given in table 3. The potash fertilizers caused significant reductions in sloughing. Triumph potatoes, which were grown on most of the other fields, did not slough appreciably during boiling. The potatoes from the potash treatments were higher in salts, and more salts leached into the cooking water. Probably the salts which leached into the cooking water helped to lower sloughing. Pyke and Johnson (29) found that they could control sloughing in potatoes by use of suitable kinds and concentrations of salts in the cooking water. They found that about 12.5 per cent of the total salt should be a soluble calcium salt and that the total salinity should be about 1 per cent. The salt content of the cooking water was about 0.1 per cent for the manure salts treatment and lower than this for the check and phosphate treatments, where sloughing was more prominent.

On potatoes from the light soils, the smaller differences in the boiling scores than in the baking scores were probably due in part to salts being leached out into the cooking water during boiling. The baked potatoes were not subject to leaching so that there was an appreciable difference in salt content of control and manure-salt treated potatoes.

TABLE 3—*Surface sloughing and salt content of Cobbler potatoes from the Red River Valley**

Soil Treatment	1942 Surface Sloughing**	1943		
		Surface Sloughing	Grams Salts per 100 Grams Dried Potatoes	Grams Salts in Cooking Water from 100 Grams Dried Potatoes
O	3.4	2.8	3.54	0.80
P	3.3	3.2	3.64	0.81
K — Muriate	...	2.0	4.39	1.05
PK — Muriate	2.6	2.2	4.29	1.06
PK — Manure salts	2.6	1.8	4.90	1.14

*In 1942 each value given is an average of measurements from 8 fields. In 1943 the values are averages from 6 fields.
**Surface sloughing : 1—none; 2—slight; 3—medium; 4—extreme.

The results indicate that the salts improved the mealiness and flavor of the potatoes significantly.

Dry Matter

On the average, potatoes contain about 22 per cent dry matter, about 70 per cent of which is starch. Since most of the dry matter is starch, a close association exists between the dry matter content and the percentage of starch in potatoes. The work of many investigators shows a positive correlation between the percentage of starch or dry matter and mealiness or quality (3, 6, 8, 14, 32, 35). There are, however, exceptions to this interrelationship so that the mealiest samples of tubers are not always those highest in dry matter or starch (1, 34, 35, 39). In the New England states the specific gravity, which may be used as a measure of either dry matter content or starch (3, 31), has been found to give a very satisfactory estimate of mealiness of quality (4, 7, 32).

The dry matter content of the potatoes used in the cooking tests are given in table 4. In both years the potash fertilizers caused a significant reduction in the dry matter content. This reduction amounted to approximately one per cent in total dry matter. The phosphate fertilizer had no influence on the dry matter in 1942, but in 1943 it was associated with a slight increase on the heavy soils and a significant increase in dry matter on the light soils. Potash fertilizers and particularly those containing chlorides have generally been found to lower the dry matter or specific gravity of potatoes (5, 21, 22, 32, 33, 35, 37). Consequently it has often been considered that they lower the quality of the potatoes. The cooking tests above show that the potash fertilizers improved the quality of the potatoes on the light soils even though they did cause a reduction in the dry matter content. Actually, these results are not out of line with investigations conducted at other stations. The potash fertilizers were not used at a high enough rate to cause a large reduction in dry matter. In Maine, Sweetman (35) found that there is a wide optimum range for potash so far as quality is concerned, but that the absence of potash in fertilizers, or its presence in very large proportion, may cause some inferiority in mealiness. In New York, Smith and Nash (32) used the following fertilizers at the rate of 1000 pounds per acre: 5-10-0, 5-10-5, 5-10-10 and 5-10-15. Only the latter caused a significant reduction in the specific gravity and mealiness of tubers. In Rhode Island (28, 39), on soils highly deficient in potash, potash fertilizers were found to cause marked improvement in the mealiness of potatoes even though the percentage of starch was lowered. When analyzed closely, the results of experimental work on potato quality indicate that potash fertilizers lower quality when used at rates to allow

TABLE 4—*Influence of fertilizers on the dry matter content of potatoes grown in the Red River Valley in* 1942 *and* 1943.

Soil Treatment	Percentage Dry Matter			
	Heavy Textured Soils		Light Textured Soils	
	1942	1943	1942	1943
O	21.38	21.64	23.28	21.70
P	21.47	21.91	23.25	22.39*
K — Muriate	...	20.38*	...	20.93*
PK — Muriate	20.87*	20.40*	22.45*	20.79*
PK — Manure salts	21.00	20.28*	22.28*	21.16*

*Significant increase or decrease as compared to the no treatment.
In 1942 the values given are averages for 6 heavy soils and 8 light soils.
In 1943 the values given for both groups of soils are averages for ratings from 8 fields.

luxury consumption by the plants of the potash salts, especially in the form of chlorides. On soils deficient in potash, potash applications to supply the needs of the plants will generally improve both the yield and quality of potatoes.

There were significant differences in the quality of potatoes from different locations. These differences are due to many factors which influence the quality of potatoes, including climatic conditions and different conditions of soil moisture, temperature and fertility (35). Rainfall is one of the more important limiting factors in the Red River Valley. During a growing season one area may receive appreciably more rainfall than another. In general, the higher quality potatoes were higher in dry matter content. On eleven fields the dry matter content ranged from 22-24.7 per cent. The average boiling and baking scores of the potatoes were 9.6 and 9.8, respectively. On nineteen fields the dry matter content ranged from 19.2-22 per cent, and the average boiling and baking scores were 8.5 and 8.4, respectively.

In using specific gravity or dry matter to measure potato quality, the results of these experiments indicate that a fertilizer should not be considered to lower quality significantly unless it causes a marked reduction in dry matter content. In Illinois, East (14) observed very little difference in the cooking quality of Rural New York potatoes which ranged from 19 to 28 per cent in dry matter. Below 19 per cent the quality decreased. Bewell (3) advocated the use of four quality classes on the basis of the dry matter content: excellent quality, over 26 per cent; good, 23 to 26 per cent; fair, 20 to 23 per cent, and poor, less than 20 per cent dry matter. This indicates that any factor which would lower the dry matter content of potatoes by three per cent should be considered to lower quality significantly. In this study the potash fertilizers lowered the dry matter content only one per cent, so it is not surprising that the beneficial effect of the added nutrient on potato quality was greater than any detrimental effect due to lowering of the dry matter content or starch. In general, however, the higher the dry matter the better the qaulity, and fertilizer combinations which either maintain the dry matter at a high level or do not lower it appreciably, should be used.

Summary

Cooking quality ratings and percentages of dry matter were obtained for potatoes grown at 30 different locations in the Red River Valley of Minnesota in 1942 and 1943 for the purpose of determining the influence of phosphate and potash fertilizers on cooking quality. The fertilizers were associated with slight but not significant increases in the

cooking quality of potatoes grown on the heavy soils. For the light soils, which, in general, are more deficient in the nutrient elements than the heavy soils, the fertilizers caused significant improvements in cooking quality and particularly in baking quality. Potash fertilizers caused a significant reduction in surface sloughing of the potatoes when boiled in distilled water. The results indicate that the improvement in quality of potatoes grown on the light soils was partially due to the fertilizers supplying nutrients needed by the potato plant and partially to the increasing of the salt content of the potatoes by the fertilizers.

Phosphate fertilizers tended to increase the dry matter content of the potatoes. Potash fertilizer, on the other hand, lowered the dry matter content significantly, the average reduction being about one per cent for the regular muriate of potash treatment of 200 pounds per acre. In general, disregarding the influence of fertilizers, the higher the dry matter content of the potatoes, the higher the boiling and baking quality.

The results indicate that on soils which are deficient in potash, potash fertilizers will improve the cooking quality of potatoes when not used excessively, even though the dry matter content may be lowered somewhat. In the fertilization of potatoes, fertilizer mixtures should be used which do not lower the percentage of dry matter appreciably.

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SECTIONAL NOTES

ALABAMA

South Alabama has closed one of the best Irish potato seasons it has experienced in several years.

The season has been ideal. Spring temperatures and rains were favorable not only for high yields but also for good quality. In general, good seed was used. Late blight, although it appeared early in the season did only a limited amount of damage because of dry weather during the critical period. The weather was cool during the early part of May. Preliminary estimates placed the number of cars shipped at 5500, with 300 bags each.

Our growers were quite well pleased with the Sebago variety, and it is likely that the acreage of this variety will be increased next year. (June 1)—L. M. WARE AND FRANK E. GARRETT.

CALIFORNIA

This has been a rather freakish year for potato production in Kern County. The yield per acre will be according to best estimates, somewhere between 10 per cent and 20 per cent less per acre than last year. Much of the reduced yield, according to those in the best position to know, has been caused by weather conditions. The weather was extremely cold until approximately the 15th of April, when it became extremely warm for a few days, and then cold again with two unusual rains during this past week that caused our growers to cease digging for approximately one day each.

In 1943 a few potato plants were discovered with a different appearance from that of any other potato trouble observed in this area, but little consideration was given to the cause. In 1944 this condition occurred again in many fields, and in 1945 there is practically no field in the county in which this disease cannot be found. It has no respect for source of seed or variety. The following investigators are working on this particular problem: Dr. J. B. Kendrick, Plant Pathologist; Dr. M. W. Gardner, Plant Pathologist; Dr. J. H. Freitag, Entomologist; and C. Emlen Scott, Extension Specialist in Plant Pathology. It is hoped that before the season is completed here that the new disease will be identified.

Last year at this date the W. F. A. had purchased many cars of potatoes under the Price Support Program. No potatoes under the Price Support Program have, to date, been purchased in 1945. It is barely possible that all of the potatoes produced in the area will go into

normal channels of trade without price support. (June 5)—M. A. LINDSAY.

* * * *

"Practically all shipments on contract and Government Orders." This notice on the Daily Shafter District Potato Report tells the story about as well as it can be told in a few words.

There is a list of buyers,—three pages long,—but a great many of them have not been able to get a single car shipped—unless they had early contracts, and even the pre-season contracts have been greatly infringed upon by Government Agency requirements.

These agencies have been taking a very large percentage of the daily production,—and apparently need even more from now on.

The potato deal here should clean up at approximately the same time as last season.

It has been most unsatisfactory from the standpoint of the buyers but it certainly has been O. K. from the standpoint of the price received by the growers. On the other hand there have been a great many complaints about light yields caused by unfavorable weather conditions, and other causes and it is questionable whether the much larger acreage this year is going to net the growers any more than did last year's crop. (June 8)—ERNEST MARX.

FLORIDA

The potato crop consisted of 12,000 acres planted to the following varieties: Sebago, 80 per cent; Katahdin, 15 per cent; Pontiac, 4 per cent and others, including Bliss and Irish Cobbler, 1 per cent. The seed were generally free from the worst seed-borne diseases. The most common disease was soft rot caused by *Erwinia carotovora*. In a few lots this trouble was very prevalent and when these lots were sorted 5 to 30 per cent of the tubers were discarded. Generally, however, loss from soft rot in most lots of seed did not exceed 1 per cent. Ring rot was found in only 2 carloads of certified seed, and only a few lots contained tubers affected with late blight.

The most common diseases found in potato fields and at packing houses were black leg, brown rot and common scab, which together caused 5 per cent loss in 1945. The only other disease causing more than a trace loss was rhizoctonia the damage attributed to it being only 0.5 per cent. The total loss of 5.5 per cent of the potato crop attributed to diseases was the lowest recorded during 14 years and was far below the average annual loss of 14.9 per cent. The extremely dry weather during most of the growing period was not conducive to the develop-

ment of late blight, soft rot and other diseases which flourish during periods of wet weather.

The 1945 potato growing season was the driest of any of the preceding 10 years, and only .91 inches of rain fell from the 30th of January to the 16th of April. The crop was not damaged by cold weather and the low yield of 125 bushels per acre can be attributed to drought during February, March and the first 16 days of April. Rains fell after the 16th of April but most of the plants were dead in potato fields before the rains started. The yield of 125 bushels per acre would have been even lower if most fields had not been irrigated once or twice during the dry period. The almost complete absence of virus diseases which reduce yields and the non-appearance of late blight which kills the foliage enabled the plants to grow and produce marketable tubers even in the fields inadequately supplied with moisture. The varieties, Katahdin and Sebago, which comprised 95 per cent of the acreage planted, generally do well under droughty conditions at Hastings. (May 31)—A. H. EDDINS.

IDAHO

At present we feel that our 1945 plantings will approach the record plantings of 1943 when Idaho had 189,000 acres. The commercial acreage is about 90 per cent planted and Idaho should finish about 10 days earlier than last year unless wet weather continues.

During the last half of May the precipitation was above normal and is apparently responsible for considerable rhizoctonia damage to potatoes planted early in May, and as a result stands of early plantings may be quite ragged. If wet weather should continue, later plantings may also suffer. From the 13th of May to the 6th of June rain was recorded on 16 days. However, with weather conditions shifting back to normal in the near future a good average stand is in prospect.

Plantings in the certified potato seed-growing areas lag considerably, principally because of heavier precipitation at the higher elevations where most of the seed potatoes are grown. It is estimated that only about 50 per cent of the seed crop is planted. The seed-producing areas are also showing a considerable increase in acreage. (June 6)—JOHN L. TOEVS.

INDIANA

The weather at the present moment is most ideal for potato production. The temperatures are quite low,—in some parts of our state as low as 35 and up to 40 or 42 degrees, which is some sort of a state record for early June. In some localities along the Ohio River, they are already

harvesting potatoes without having to put on a dust or spray for leafhoppers, potato bugs, or flea beetles. In other sections, however, further north, the flea beetles and leafhoppers are causing some damage as a few of the growers thought that they would not have to put on a control this year but were surprised to find the insects present and control measures are in operation at this time.

Our prospects in Indiana look very, very good—in fact I do not believe they have ever looked better. Some acreages were delayed because of climatic conditions and I presume that the balance of our commercial crop will be planted either this week or next. There is some shortage of seed for those who wish to plant potatoes now and who have not made arrangements for seed previously.

The recent report that some varieties of potatoes contained as much vitamin C as was found in tomatoes made a good news story and consequently there has been an increased consumption of potatoes since a number of people have asked about the statement and the merchants claim that the sales in their stores have been greater than ever. (June 4)—W. B. Ward.

KENTUCKY

The continuation of wet weather that caused planting to be delayed 10 days beyond the normal deadline,—the 10th of April—is resulting in a splendid crop prospect. The low mean temperature of 61 degrees for May has also helped, too, and the crop as of this date, the 5th of June, is less than 15 days behind normal. Except for sudden, abnormally hot weather a fine crop should result. The Irish Cobbler is still our favorite variety but Sequoia, which has outyielded it in scattered plantings for the past two years, is coming to the fore.

Our acreage is 5 to 10 per cent smaller than that of last year,—when some harvesting difficulties were encountered,—but almost 15 per cent higher than the "intentions," as of January, were this year. (June 5)—John S. Gardner.

NEW JERSEY

The New Jersey potato crop, in general, is looking very well and at present prospects point to a good yield. Late blight has appeared in numerous fields during the past week or two,—the first infected area being found on the 1st of June. This is the earliest dates that late blight has ever been reported in the state. At the present time Black leg is also quite prevalent in many fields.

Our growers are planning to start harvesting early in July and it

is quite likely that many of our Cobblers will be harvested by the middle of the month. Most of our growers are very disappointed with the announcement concerning the W. F. A. price support program regarding a support price on size B's only if the U. S. 1's and U. S. Commercials grown with them are also offered at support prices. The State Potato Committee has met twice with W. F. A. officials in an effort to have this statement modified,—but to date,—without success. (June 16)—J. C. CAMPBELL.

NEW YORK

The Long Island potato crop is ten days or two weeks earlier than normal.

It is making excellent progress. The cool wet weather has been very favorable for growth. Late blight is widespread but universal spraying is holding it in check. This is the earliest date, on record, for the appearance of the late blight disease.

In a few fields Fusarium was so bad, in causing rot of the seed that it was necessary to replant. Generally speaking, stands are excellent. (June 11)—H. R. TALMAGE.

* * * *

Weather and soil conditions have been unfavorable for planting potatoes in upstate New York during May and early June. A shortage of seed will result in a reduction of the acreage reported earlier under intentions to plant. The warm weather in March and early April caused a great loss from rotting of seed and prevented sprouting. The cold wet weather which followed in May, caused some rotting of seed after planting. H. J. Evans, Manager of the Seed Potato Association, reports that many orders for seed are coming in later than usual. These orders will remain unfilled as the supply is entirely exhausted.

Cold weather and frosts in late May resulted in some damage to muck land potatoes and caused some decay of seed in fields planted on upland. Similarly the plants in several fields on Long Island were frozen back to the ground with the result that the maturity of the crop will be delayed and the yield somewhat reduced.

The Long Island crop, generally speaking, is in excellent condition at this date (June 13). However, late blight has appeared in both Nassau and Suffolk counties and weather conditions have been ideal for its dissemination. Nearly every field shows some late blight and if the present cool wet weather continues the disease may reach epiphytotic proportions. Nearly all the growers applied Bordeaux Mixture

too late for best results. Foliage insects have not been so prevalent as usual because of the cool weather. (June 12)—E. V. HARDENBURG.

NEBRASKA

The weather is, and has been, the chief topic of conversation in this territory for some time. It has been especially cold for this time of year, and also very wet during the month of May. This weather has continued up to the present moment. Since potato planting in the main crop areas of western Nebraska should begin this week, every one is hopeful that the sun will shine soon.

As a result of the recent rainfall, there will be an abundance of moisture in the seed beds. Unless this weather continues to delay planting, and possibly cause seed piece decay after planting, the crop should get off to a good start.

The early crop in central and eastern Nebraska is reported as progressing fairly well. The cold weather during April and May had an effect on this crop, in delaying its growth, and in causing rather thin stands. Considerable damage is reported because of rhizoctonia.

The indications for planting in the western main crop areas are for a small increase in the commercial plantings, and a larger increase in certified plantings. The amount of increase in certified plantings is at present estimated from 15 to 20 per cent. Our records will not be available until the end of the month, after the planting is completed.

There is a demand for more seed potatoes at this moment, because of numerous severe hail storms that have knocked out winter wheat and other grain fields. There is very little likelihood of getting additional seed, because the demand has been good throughout the spring, and our supply is exhausted. (June 15)—MARX KOEHNKE.

NORTH CAROLINA

There is a smile on the face of every grower of early Irish potatoes in eastern North Carolina. This is quite a change from the two previous seasons and a great relief to those of us concerned with potato problems.

It is estimated that more than 50 per cent of the crop has already been moved. Under normal conditions harvesting does not begin in some of the earliest fields until the latter part of May. To date, the 30th of May, 1543 cars have been shipped and we estimate the equivalent of 1000 cars has moved by truck. Harvesting conditions have been almost ideal since we have had very few hot days or nights. For the most part the night temperatures have ranged between 54° and 60°.

The last two days (May 29 and 30) have been rather warm but the nights have been cool.

Late blight has damaged vines in some fields rather severely, but up to this time there has been no tuber rotting since digging has been in progress and all affected plants have been dug promptly. We have had more late blight this year than usual because of the cool nights, intermittent rain and some fog. Growers were considerably concerned by the large amount of leafroll found in seed stock this year. Some fields have run as high as 50 per cent. In fact, some growers complained so strenuously that an official from Maine visited the area during the week of the 21st of May. It was indicated that the virus was spread by aphids late in the season, since inspected fields showed less than 1 per cent leaf roll at time of inspection. (May 31)—M. E. GARDNER.

OHIO

The early potato prospects are excellent and the yield should be double that of a year ago, when drought reduced the crop about fifty per cent. It has been dry for the past two weeks but a good rain fell on the 11th and 12th of June.

Harvesting should start about two weeks earlier than last year. This would mean some volume by the latter part of July.

There has been an outbreak of aphids but commercial damage has been reported by only one grower. Control was difficult because of the cool weather. Parasites are abundant enough, however, to give sufficient control.

The potato marketing program is receiving increased interest and at present the prospect for volume is about double that of last year. The Association established an office in Columbus a year ago and a very successful year has been completed. (June 14)—EARL B. TUSSING.

SOUTH CAROLINA

Our potato season closed officially on the 1st of June, although a few straggling lots are still moving. The excellent weather conditions, which prevailed throughout this year, insured good yields and late blight. The blight injured all potatoes by killing the vines prematurely. About 70 per cent of the acreage was planted early and suffered a 25 per cent reduction in expected yield. The 30 per cent planted later was damaged quite heavily because the vines were killed before the tubers sized up.

Many growers have reported average yields of 150-200 bags per acre,—which is about double the normal 10-year average. Although

tuber infection with late blight did occur, the cool weather during harvesting kept down the rot in transit so that no serious loss was incurred. Blackleg was serious on Sebago grown from Maine seed. (June 2)—W. C. BARNES.

SOUTH DAKOTA

The heavy general rains during the past two weeks have supplied plenty of moisture for the potato crop for the time being. Fields are getting weedy because of the inability of growers to start cultivation. Some late fields have not had the ridges dragged down. The potatoes in our early-planted crop have emerged, although the stands, in many fields, are not very good. Plantings were completed around the 26th of May and our reports show an increase in the certified acreage of, at the least, 20 per cent.

In 1944, 6,900 acres were entered for certification and it is expected that at least 8,500 acres will be entered this season. Bliss Triumphs make up the largest part of this acreage with Irish Cobblers, second; and Pontiacs, third. The acreage of Early Ohio's entered for certification will be very small this season.

Our field inspection will start on the early-planted stock about the 18th of June. The certified potato acreage in South Dakota will again be concentrated in the northeastern part of the state with the majority of the acreage in the eastern part of Clark county. The altitude and type of soil in this section of the state is ideal for the production of potatoes. (June 9)—JOHN NOONAN.

VERMONT

Wet, cold weather has seriously set back planting of potatoes in Vermont. From the middle of April to the present date there have been very few days on which there was no rain. During May all except the lightest of lands were so wet that planting was absolutely impossible.

On the 4th of June a check-up showed that only about one-third of the intended acreage of the larger commercial and seed growers had been planted. Planting will continue until the middle of the month, but few growers particularly of Green Mountains, will wish to take chances on planting much later. It is, therefore, probable that planting will not be as large as had been intended.

It is also the general opinion that the number of small plantings of potatoes in home and victory gardens is less than last year.

Plantings for seed certification will probably be more largely in the hands of large growers than formerly. (June 12)—HAROLD L. BAILEY.

WASHINGTON

The spring in the State of Washington has been unusually cool with an excessive amount of rainfall. The result has been that the growth of potatoes has been somewhat delayed for this time of the year.

Planting intentions which have now been largely completed, however, indicate that the acreage entered for seed certification will be approximately 2,000. This will be an increase of more than 50 per cent above the 1944 acreage. Our commercial potato plantings likewise have been considerably increased. As nearly as we can estimate there will be at least 25 per cent additional acres of commercial potatoes than were grown last year.

There has been quite a change in commercial plantings in the acreage of the principal varieties planted. Where formerly we have been planting approximately 75 per cent of the Netted Gem variety,—with the balance largely White Rose and miscellaneous early varieties; this year there is 50 per cent White Rose and about an equal amount of Netted Gems,—with only a very small planting of other early varieties.

It is of course too early to predict what the production may be, but the cool temperature is resulting in more than ordinary damage by the rhizoctonia fungus. This may result in more or less reduction in production and quality. (June 5)—CHARLES D. GAINES.

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PRELIMINARY EVALUATION OF SOME SOIL DISINFESTANTS FOR CONTROLLING SOUTHERN BACTERIAL WILT OF POTATOES[1]

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Southern bacterial wilt (*Pseudomonas solanacearum*) of potato is one of the major problems confronting the potato growers of eastern North Carolina, as the soils of many farms are already infested. Losses from year to year vary with the seasonal fluctuations in climate, but throughout the section the disease develops to some extent each year.

Although crop rotation and clean cultivation offer some means of controlling Granville wilt of tobacco, a disease caused by the same bacterium (1 & 2), the occurrence of numerous wild and cultivated suscepts of the pathogen renders similar methods of control useless or at best uncertain in the control of Southern bacterial wilt in the potato producing area. Soil treatment with chemicals possibly holds some immediate promise as a means of controlling the disease. The preliminary phases of this approach to controlling the disease under eastern North Carolina conditions are herein reported.

SOIL TREATMENTS

The experiment was set up in a 5 x 5 Latin square design with plots 1 x 3 rods. The soil was Bayboro loam, high in organic matter. The variety used in all tests was the Irish Cobbler, and no attempt was

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made to prevent the mixing of soil from plot to plot during cultivation, harvesting or plowing. The five treatments were control, lime alone, sulfur-lime, modified urea, and ammonium thiocyanate.

Smith and Clayton (3) report that urea (Uramon) applied at the rate of 500 to 1,000 pounds per acre 10 weeks before planting effectively controlled Granville wilt (*Pseudomonas solanacearum*) of tobacco. Uramon[4] was first tested for the control of bacterial wilt of potatoes in 1942 at the rate of 800 pounds per acre. In this test the chemical was broadcast by hand February the 19th, 1942, and immediately disked in to a depth from 4 to 6 inches. The potatoes were planted on the 27th of March. Although the growing season was fairly dry, the plants made a good vegetative growth. The yield in general, was poor. At harvest time (June 24), there was no evidence of disease control from the urea treatment.

The mechanism by which urea affects control of *Pseudomonas solanacearum* in tobacco soils is not understood. But it is suspected that the ammonia liberated by the decomposition of urea in some way plays a rôle. It was postulated that the liberated ammonia in the above experiment was adsorbed or chemically combined because of the high exchange capacity of the soil. Using this as a working hypothesis, samples of the soil were treated with a saturated calcium hydroxide solution in the laboratory until the pH was shifted from 5.6 to neutral.[5] From this test it was calculated that approximately five tons of hydrated lime per acre would be required to bring about this change in hydrogen-ion concentration under field conditions. It was also assumed that such an addition of lime would saturate the adsorptive capacity of the soil, thus leaving the greatest part of the ammonia liberated from the urea free to act as an eradicant. In this combination treatment the urea was applied at the rate of 1,000 pounds per acre.

The sulfur-lime treatment successfully used by Eddins (4) was also tested. The sulfur[6] was applied at the rate of one ton per acre. When the average pH of the treated soil reached 3.6, 4,650 pounds of hydrated lime were applied to the acre in order to change the soil reaction back to that of the untreated soil.

Ammonium thiocyanate[7] was used by Bell (5) to free infested soil of the potato black wart pathogen (*Synchytrium endobioticum*). This

[4]Supplied by E. I. duPont de Nemours and Company, Wilmington, Delaware.

[5]Suggested by O. F. Jensen, E. I. duPont de Nemours and Company, Chapel Hill, North Carolina.

[6]Commercial flour sulfur, supplied by Freeport Sulphur Company, 1804 American Bank Building, New Orleans 5, Louisiana.

[7]Supplied by Koppers Company, Pittsburgh 19, Pennsylvania.

chemical was included in the test and applied at the rate of 1,000 pounds per acre.

For the purpose of testing the influence of heavy lime applications (4, page 39) on the incidence of wilt, hydrated lime was applied at 5,700 pounds per acre.

In 1943, the hydrated[8] lime applications for the lime urea and lime alone treatments were made on the 14th of January in corn stalks of the previous year's crop. The freshly applied lime was double disked in to a depth of 4 to 5 inches. On the 4th of February, the sulfur, ammonium thiocyanate, and urea were applied. The sulfur and urea were broadcast by hand. Ammonium thiocyanate being very hygroscopic and slightly caustic to the skin was therefore successfully applied in solution. The soil was plowed 6 to 8 inches deep soon after treatment in preparation for planting and the crop was planted on the 3rd of April. Eddins (4) recommends that the sulfur treatment be made several months in advance of planting. Since the plots in the present experiment were machine-planted, the sulfur plots were also planted to simplify the planting operation even though it was not expected that sufficient time would elapse for the full effects of sulfur treatments to become effective for this crop.

Experimental Results

By the 27th of April, 1943, the potatoes were emerging and the soil surface of the ammonium thiocyanate treated plots was brown in color. The seed pieces in these plots were injured, and in many cases the buds had been killed. In other cases, small tuber-like structures had developed at the eyes, and these in turn were sending out apparently normal sprouts. Since the stand in these plots was markedly reduced, two center rows in each plot were replanted by hand. The plants in the sulfur treated plots emerged more slowly than those in the remaining treatments and control.

During the latter part of May and throughout June the growing season was very warm. Southern bacterial wilt was serious in the early potato section. At harvest time (June 29), the plants in the ammonium thiocyanate plots were in bloom and tuberizaton was in progress. The largest tubers in these plots were about two inches in diameter. The plants growing in the sulfur treated plots showed considerable injury. They were yellowish, stunted and had developed a corky, deeply cracked cortex on the underground stem. Tubers were heavily corked and deeply russeted. The plants on the remaining treat-

[8]Hydrated lime was used to hasten the change in soil reaction.

ments were normal in size, but those on the lime-urea plots were dark green in color. It was evident that the disease did not develop uniformly over the land chosen for the experiment, since for the control plots, the number of diseased plants varied from 8 to 62 in the two center rows sampled.

The incidence of bacterial wilt was determined on the basis of plant symptoms on the 17th of June, and soil pH analyses were made on the 4th. The average number of diseased plants for the several treatments, and the pH data are presented in table 1.

TABLE 1.—*Number of plants having southern bacterial wilt in treated plots in* 1943 (*average of* 5 *replications*).

Treatment	Diseased Plants—Number	Soil pH
Control	30.6	4.48
Lime	26.6	5.61
Sulfur-lime°	11.2	3.77
Lime-urea	4.8	5.48
Ammonium thiocyanate	0.0	4.59
L. S. D. 5 per cent	11.8	.53
L. S. D. 1 per cent	16.3	.73

°Lime of this treatment applied later, November 30, 1943.

The ammonium thiocyanate, lime-urea, and sulfur treatments gave a significant reduction in the incidence of disease. While the comparison of plants in the ammonium thiocyanate treatment is not valid as they were younger, the total absence of disease in the younger plants suggests eradicative action by the treatment. The addition of lime to the urea treatment apparently made the latter effective. Lime alone had no beneficial effect in controlling the disease.

Following the harvesting of the potato crop, the treated plots were allowed to grow to weeds[9] during the summer of 1943. On the 30th of November, the sulfur-treated plots had an average pH of 3.66, and hydrated lime was added at the rate of 4,650 pounds per acre.

In 1944, two test rows were planted through the center of each

[9]Cocklebur was the dominent weed.

plot. To compensate for the mixing of soil from plot to plot, a 5-foot margin was cleared from either end of all plots. Disease observations were made at weekly intervals starting the 23d of May. All diseased plants were counted and pulled so as to eliminate any error in making later counts. The last examination was made on the 28th of June. The pH data for the several plots, and a summary of the wilt data are presented in table 2.

TABLE 2.—*Number of plants having southern bacterial wilt in treated plots in* 1944 (*average of* 5 *replications*).

Treatment	Diseased Plants—Number	Soil pH
Control	53.0	4.52
Lime	68.0	5.17
Lime-urea	16.0	5.95
Sulfur-lime	0.4	4.85
Ammonium thiocyanate	2.2	4.32
L. S. D. 5 per cent	28.4	.40
L. S. D. 1 per cent	39.2	.55

The three treatments lime-urea, sulfur-lime, and ammonium thiocyanate again significantly reduced the incidence of disease, and were not significantly different from one another. However, the lime-urea treatment is possibly less effective than the other two treatments. Lime added to the soil had no effect on the incidence of disease. The soil pH attained by the lime treatment was considerably more acid than the lime treatment reported partially effective by Eddins (4). The control obtained by the lime-urea treatment may have been due, in part, to the large dosage of hydrated lime used in the combination treatment. It is believed, however, that the urea component was the primary controlling agent of the treatment.

Most diseased plants in the ammonium thiocyanate plots were found in the ends of the plots, suggesting that soil movement during cultivation, plowing, etc., introduced the pathogen into the treated plots. There was no evidence of injury to plants from ammonium thiocyanate applied in 1943.

Discussion

These studies have been preliminary in nature and may suggest further study on the control of *Pseudomonas solanacearum* through soil treatment. The amount of lime in the lime-urea treatment may be far in excess of that needed for effectiveness. This treatment may be improved by altering the rate of either component. The sulfur-lime treatment, although very effective, is probably too expensive when used on soil high in organic matter (4). However, there are infested soils in eastern North Carolina that possibly could be treated with 1,000 pounds of sulfur per acre or less and still obtain good control. The ammonium thiocyanate treatment looks promising and should be tested at lower dosages. It is possible that lower dosages applied in October or November would be converted sufficiently in the soil to be non-toxic to the first planting in February or March. Because of war emergencies, ammonium thiocyanate is being produced as an intermediate chemical product, and its cost for soil treatment could not be determined. If useful at lower rates of application and in less refined form, this product may be both practical and effective.

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BREEDING FOR RESISTANCE TO LATE BLIGHT IN THE POTATO

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Twelve years ago the United States Department of Agriculture, in cooperation with the Maine Agricultural Experiment Station, began a program for breeding potato varieties with high yield, good market qualities, and good cooking qualities, combined with resistance to late blight (*Phytophthora infestans* (Mont.) DBy.). During this time several reports of progress have been published. In addition, the Sebago variety, which is moderately resistant in both vines and tubers, has been increased and distributed to growers. How well this variety has been received is shown by the fact that in 1944 1,801,596 bushels of certified seed were produced in 11 states. About 85 per cent of this amount was produced in Maine, but varying amounts were reported also from Maryland, Michigan, Minnesota, New Jersey, New York, North Dakota, Pennsylvania, Vermont, Washington, and Wisconsin. The present paper is an attempt to bring the results of the blight-resistant phase of potato breeding up-to-date and to discuss some of the newer family lines, selections from which show much higher degrees of resistance than Sebago.

REVIEW OF LITERATURE

Stevenson *et al.* (12) reported that selections resistant to late blight had been obtained by selfing a susceptible variety, by crossing two resistant varieties, by crossing a resistant variety and a susceptible one, and by crossing two susceptible varieties. Progenies related to the so-called *W* races of Germany, sent to us by K. O. Müller, Berlin, Dahlem, showed marked degrees of resistance.

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In another report Stevenson *et al.* (11) indicated that the most promising seedling varieties are not always found in the most resistant progenies. The progeny of one cross, President (No Blight) x Ekishirazu, was highly resistant to late blight, but the tuber shapes were so poor and the yields so low that none of the seedlings could be considered as a commercial possibility. The same was said for the selections from the German *W* races. Many of them showed the highest degree of resistance obtained in these experiments, but they were all mediocre in appearance and performance. The most promising seedling was No. 44488, a selection from the cross Chippewa x Katahdin.

In the fall of 1938 seedling 44488 was named Sebago (10) and distributed to growers. This variety is moderately resistant to late blight in both vines and tubers. It was much less resistant than a number of other seedlings in the tests, but it was a vigorously growing variety that produced high yields of tubers of high market and cooking quality, and it was highly resistant to mild mosaic, a combination of characters the others did not have.

The yields of sprayed plots as compared with non-sprayed plots of two susceptible varieties, two resistant varieties, and four resistant seedling varieties showed (9) that under conditions for blight that occurred in Maine in 1937 it would not pay to spray Katahdin, Sebago, or the remaining five resistant varieties. Green Mountain was the only one that needed protection that year. This does not mean that Katahdin is resistant to blight. It is susceptible; and although it escapes occasionally, good farm practice requires that it be sprayed every year the same as Green Mountain. In 1938, however, spraying would have been profitable on all the varieties in the test. It was pointed out, that blight on Sebago even under the severest epidemic conditions, such as occurred in 1938, is more easily controlled than on Green Mountain. Sebago has the added advantage that it is much less subject to tuber rot caused by late blight than is Green Mountain.

Bonde *et al.* (3) emphasized the resistance to late blight in the tubers of certain potato varieties and seedling progenies. A high percentage of the seedlings were resistant to tuber and foliage infection when one or both parents were resistant. Resistance in the foliage, however, was not necessarily associated with resistance in the tuber. Some seedlings with resistant foliage had tubers that were susceptible to infection. Other seedlings produced susceptible foliage and resistant tubers. These facts indicate that foliage resistance and tuber resistance are conditioned by different genetic factors. The tubers of some of the varieties studied

were susceptible to late blight while immature but more resistant as they matured.

Artificial inoculations with zoospores from the varieties President and Sebago, which have blight-resistant foliage, did not infect the tubers of certain resistant varieties more readily than did zoospores from the susceptible Green Mountain variety. It did not appear that the virulence of the late blight fungus had been increased in nature by being propagated on these resistant varieties.

President, Sebago, and several seedling varieties had been grown for 10 years in Aroostook County, and though the amount of infection varied somewhat with the seasonal conditions there was no evidence that they had lost their resistance.

Other workers in this country and in Europe are interested in this problem and have met with varying degrees of success. Reddick (5) stated in 1937 that although no varieties of blight-immune potatoes were in commercial production, it appeared that this would only be a matter of time and that the most important duty ahead was to make systematic tests of the hybrids for adaptability to field conditions and for culinary qualities. Even though no existing selection might meet the requirements, a method had been developed by which other blight-immune seedlings can be produced in large numbers, from which suitable selections could be made.

Later Reddick (6) reported on the problems encountered in breeding varieties of potatoes immune to late blight. This disease, he said, is found in Mexico, and it is in that country that resistant and immune potatoes, such as *Solanum demissum,* are found. By crossing *S. demissum* with cultivated varieties and by repeated back-crossing to cultivated varieties blight-resistant varieties with commercial promise have been obtained. In discussing the parasite, the author stated that *Phytophthora infestans* never forms oospores in North America but persists from year to year in a vegetative condition; that the virulence of the zoospores can be stepped up by passage through a resistant host; and that the higher level of virulence is not lost when the organism is cultured on a susceptible variety.

In another paper Reddick and Mills (7) further emphasized this phenomenon. They reported an increase in virulence of *Phytophthora infestans* by the passage of cultures successively through varieties each possessing a higher degree of resistance than the preceding host, until a point was reached where a number of hybrids that previously had given immune reactions in comparison with standard varieties were severely infected.

TABLE 1—*Reactions of parents of progenies to late blight.*

Variety	Year	Plots Tested	Plots in Different Classes of Infection[1]								Mean	Standard Error Single Plot
			1	2	3	4	5	6	7	8		
		No.	No.	No.	No.	No.	No.	No.	No.	No.		Class
Green Mountain	1937	299	0	0	0	0	0	233	53	13	6.26	0.53
Do	1938	84	0	0	0	0	0	0	0	84	8.00	.00
Do	1939	161	0	0	0	0	0	0	0	161	8.00	.00
Do	1940	41	0	0	0	0	0	0	4	37	7.90	.32
Do	1941	80	0	0	0	0	0	4	21	55	7.64	.57
Do	1942	41	0	0	0	0	0	0	11	30	7.73	.45
Do	1943	36	0	0	0	0	0	3	16	17	7.39	.65
Do	1944	37	0	0	0	0	0	34	3	0	6.08	.28
President	1937	257	0	0	82	175	0	0	0	0	3.68	.47
Do	1938	84	0	0	11	73	0	0	0	0	3.87	.35
Do	1939	129	0	0	72	57	0	0	0	0	3.44	.50
Do	1940	39	0	0	0	0	0	1	3	35	7.87	.40
Do	1941	20	0	0	0	1	13	6	0	0	5.25	.56
Do	1942	38	0	0	0	0	1	33	4	0	6.08	.37
Do	1943	36	0	1	8	26	1	0	0	0	3.75	.56
Do	1944	38	0	0	0	5	30	3	0	0	4.95	.46
Earlaine	1937	66	0	0	0	0	0	0	0	66	8.00	...
Do	1940	11	0	0	0	0	0	0	0	11	8.00	...
Do	1941	4	0	0	0	0	0	0	0	4	8.00	...
Do	1944	1	0	0	0	0	0	0	0	1	8.00	...
S. 46952	1944	1	0	0	0	0	0	0	0	1	8.00	...
Chippewa	1940	1	0	0	0	0	0	0	0	1	8.00	...
Do	1941	1	0	0	0	0	0	0	0	1	8.00	...
Katahdin	1937	20	0	0	0	0	1	18	1	0	6.00	.32
Do	1940	1	0	0	0	0	0	0	0	1	8.00	...
Do	1941	1	0	0	0	0	0	0	0	1	8.00	...
Do	1944	1	0	0	0	0	0	1	0	0	6.00	...
Houma	1941	1	0	0	0	0	0	0	0	1	8.00	...
Do	1944	1	0	0	0	0	0	0	1	0	7.00	...
Earlaine No. 2	1944	1	0	0	0	0	0	0	1	0	7.00	...
Russet Rural	1937	6	0	0	0	0	0	1	2	3	7.33	.77

TABLE 1—*Reactions of parents of progenies to late blight—(Continued)*

Variety	Year	Plots Tested	1	2	3	4	5	6	7	8	Mean	Standard Error Single Plot
			Plots in Different Classes of Infection[1]									
		No.	No.	No.	No.	No.	No.	No.	No.	No.		Class
Earlaine No. 2	1944	1	0	0	0	0	0	0	1	0	7.00	...
Russet Rural	1937	6	0	0	0	0	0	1	2	3	7.33	.77

TABLE 1—*Reactions of parents of progenies to late blight*—(*Continued*)

Variety	Year	Plots Tested	1	2	3	4	5	6	7	8	Mean	Standard Error Single Plot
			Plots in Different Classes of Infection[1]									
		No.	No.	No.	No.	No.	No.	No.	No.	No.		Class
Ostragis	1941	1	0	0	0	0	0	0	0	1	8.00	...
S. 41956	1941	12	0	0	0	0	0	0	1	11	7.92	.95
Sequoia	1944	1	0	0	0	0	0	1	0	0	5.00	...
Sebago	1937	16	0	0	0	5	11	0	0	0	4.69	.45
Do	1940	6	0	0	0	0	0	2	4	0	6.67	.63
Do	1941	5	0	0	0	0	0	1	0	4	7.60	.87
Do	1944	1	0	0	0	0	1	0	0	0	5.00	...
Ackersegen	1937	19	0	10	9	0	0	0	0	0	2.47	.53
Do	1940	1	0	1	0	0	0	0	0	0	2.00	...
Do	1941	1	0	0	1	0	0	0	0	0	3.00	...
X 336-7	1937	36	0	0	0	30	6	0	0	0	4.17	.38
Do	1940	1	0	0	0	0	0	1	0	0	6.00	...
X 336-18	1937	53	0	0	6	47	0	0	0	0	3.89	.97
Do	1940	2	0	0	0	0	1	1	0	0	5.50	1.00
X 336-123	1944	1	0	0	0	0	1	0	0	0	5.00	...
X 336-144	1940	18	0	0	0	0	4	14	0	0	5.78	.41
X 336-144	1941	12	0	0	0	0	3	9	0	0	5.75	.42
Do	1944	1	0	0	0	0	1	0	0	0	5.00	...
X 96-28	1944	1	1	0	0	0	0	0	0	0	1.00	...
X 96-44	1944	1	1	0	0	0	0	0	0	0	1.00	...
X 96-56	1944	1	0	0	0	0	0	0	0	0	1.00	...

[1]Classes of infection:
1—Immune.
2—Occasional leaf with late blight pustules.
3—8 to 12 compound leaves per hill with late blight spots.
4—Approximately half of leaflets with blight spots.
5—Approximately two-thirds of leaves dead.
6—All but apical leaves killed; stalks green.
7—Stalks green, all leaves killed.
8—All leaves and stalks dead.

A report that corroborates in part the findings of Reddick and Miils regarding increased virulence was given by Vinogradova (13). He stated that cultures of the parasite raised on leaves of a resistant variety, 8670, proved more virulent than ordinary cultures; when the former were reproduced on tubers, however, they lost their virulence. These forms were considered as modifications rather than as distinct races.

Another factor that has a tendency to complicate the problem is the existence of biological races of *Phytophthora infestans*. Lehmann (4) studied the effects of 8 such races on progenies obtained from crosses between *Solanum demissum* and *S. tuberosum*. He found that they showed sharply contrasted differences in their virulence. The weakest action was possessed by race 1, which seriously injured only 2 of the 50 selections tested. The strongest virulence was shown by race 8, which vigorously attacked 47 of the selections and weakly attacked the remaining 3. In tests of tuber resistance of commercial varieties it was found that early-maturing varieties were as susceptible as late-maturing ones.

Black (1) tested a number of species hybrids with the common strain of blight "A" and a more virulent form "B." He suggested that the resistance to the two blight strains is controlled by two genes of different phylogenetic origins, which he names *Ra* and *Rb*. *Ra* confers resistance to the A strain and *Rb* to both strains. An increased concentration of *Ra* genes does not however confer resistance to the *B* strain of blight.

Materials and Methods

Varieties showing various reactions to late blight, from complete susceptibility to the common forms of blight to immunity, have been used as parents in this project as shown in table 1. Green Mountain under ordinary conditions is very susceptible, but it has other desirable characters, such as high yielding ability and good cooking quality. President, a Dutch variety described by Bonde (2) as Foster's Rust-proof, has an intermediate type of resistance that, under ordinary field conditions, prevents heavy injury to the plants. In all the tests Green Mountain and President have been used not only as parents but as checks to measure the severity of the blight epidemics. Earlaine is very susceptible, but contributes resistance to mild mosaic, good tuber shape, and earliness. Seedling 46952 is susceptible, however, it is early, has excellent tuber shape, and is resistant to ring rot. Chippewa is highly susceptible to late blight, but is intermediate in maturity and is a high-yielding variety. Katahdin is susceptible to the late blight fungus,

but is pollen-fertile, is immune in the field to mild mosaic, is vigorous, and is widely adapted. Houma is very susceptible, but contributes high yield, relatively high dry-matter content, and good tuber shape. Earlaine No. 2 is late, pollen-fertile, very high yielding, but low in dry matter content. Russet Rural is vigorous and grows quite well under rather adverse conditions. Ostragis is susceptible to blight but highly resistant to common scab. Seedling 41956 does not show any resistance to late blight but it is immune to latent mosaic. Sequoia is moderately vine-resistant but tuber-susceptible. It is, however, a very high-yielding variety and resistant to hopperburn and flea beetle injury. Sebago is moderately resistant to blight in both vines and tubers, and it is resistant also to mild mosaic and yellow dwarf. Ackersegen shows a high degree of resistance to blight, but it is very late and its tubers have yellow flesh and irregular shape, so that it is not a very desirable parent. Selections x336-7, x336-18, x336-123 and x336-144 are from the cross President x Katahdin. They all show an intermediate type of resistance to blight and three of them, x336-7, x336-18, and x336-144, show a relatively high degree of resistance to ring rot.

A number of selections made from the seedling progenies related to the German *W* races were highly resistant to the common forms of the late blight fungus. Some of these were early-maturing, but all showed low-yielding ability (12). Four of these selections, 3895-2, 3895-13, 3897-90, and 4050-9, were crossed with various varieties and seedlings. Some of the best combinations in the first series of crosses possessed the resistance to blight of the German varieties, were early in maturity, and had very good cooking quality. Their yielding ability was not so high as that of the best commercial varieties, but in this respect they were a great improvement over the German parents. Selections from this series of crosses were crossed, in turn, with some of the commercial varieties and most promising seedlings. From this second series of crosses a number of selections have been made, which in preliminary trials yield as high as the old commercial varieties and have immunity from the common forms of late blight found in the grandparents that were selected from the German *W* races.

In 1932 the initial natural late blight infection involving an occasional leaf in a four-acre plot on Aroostook Farm, Presque Isle, Maine, was observed on the 20th of July. Very favorable temperature and moisture conditions during August induced a late blight epiphytotic that killed the Green Mountain and the equally blight-susceptible varieties by the 1st of September.

Because natural field infection worked so well in 1932 for late-

blight infection, it was decided to let nature again cause the epiphytotic in the test plots in 1933. However, conditions for late blight in 1933 were so unfavorable that by the end of the season only an occasional plant even among the susceptible varieties had become infected.

Earlier experience with the late blight organism had shown that infection could be induced under greenhouse and field conditions by spraying zoospores onto the plants. From 1934 to 1938 the test plots on Aroostook Farm were sprayed with late-blight spores when late blight appeared in commercial fields and on potato dumps or waste piles. The first inoculations were made about the middle of July with spores obtained either from commercial fields or from waste piles. Usually three to five inoculations were essential to induce an infection that would kill the susceptible varieties by the 1st of September on Aroostook Farm where conditions for natural infection of late blight were not always favorable.

From 1939 to 1944 the late blight test plots were located on alluvial soil along the Aroostook River where more favorable humidity prevailed than on Aroostook Farm, which favors late blight infection. However, on these plots initial infections were produced by spraying the plots during the first week in July with zoospores, after late blight was found on potato dumps and in some of the commercial fields in Aroostook County.

In 1941 and 1943 a common race of late blight, cultured on lima-bean agar, was used for inoculating the test plots, whereas in 1939, 1940, 1942, and 1944 artificial inoculations for the test plots were secured from blighted potato dumps. Three to five inoculations at 5- to 7-day intervals early in July favored a blight epidemic that killed the susceptible varieties by the third week in August when readings on blight reactions were made.

The data are taken in eight classes. In class number 1 near-immunity exists, with an occasional small pustule developing late in the season; in number 2 an occasional leaf shows late blight, the pustules usually developing earlier in the season and becoming larger in size than those of number 1; in number 3, 8 to 12 compound leaves become infected; in number 4 approximately half of the leaflets show blight pustules; in number 5, about two-thirds of the leaflets develop blight spots; in number 6 all but apical leaves are killed but stalks are still green; in number 7 the stalks are still green, but all the leaves are killed; and in number 8 all the leaves and stalks are dead. The first three classes show more resistance than do any of the commercial varieties that are produced at present; there is no appreciable injury to the plant. Number

4 shows an intermediate type of resistance with little apparent injury to the plant. The other four classes show injury in increasing degrees reaching a climax in class 8, the plants of which are dead. Experience has shown, however, that the plants in class 8 are not all killed by late blight but may be dead because of factors for early maturity or injuries from insects and early blight. It should be remembered that the test plots are sprayed with blight spores and not bordeaux mixture, so are open to the attacks of various diseases and insects that may be prevalent in the vicinity.

Results

The late blight data showing the reactions of progenies related to Chippewa, Katahdin, Sebago, Ackersegen, and President are given in table 2.

The first indication of resistance observed in the present program was found in a cross of the susceptible varieties Chippewa and Katahdin. From such a cross tested in 1932 a number of selections were made that were moderately resistant. Chippewa itself is usually killed by the disease, and Katahdin is always severely injured if not entirely killed (Table 1). Another lot of seedlings of this same cross was tested in 1939 with comparable results. None of these showed the highest type of resistance, but a few were intermediate in their reaction. The mean for the whole line was 7.09, which does not indicate much resistance (Table 2).

Sebago, a selection from this cross, was backcrossed to Katahdin. In 1939 the mean for a population of 280 seedlings was 5.68, which indicates a significantly higher resistance than that shown in the Chippewa x Katahdin cross (Table 2). When President, which on the average showed a slightly higher degree of resistance than Sebago, was crossed with Katahdin, the mean for the line was 5.30 with a higher percentage of seedlings in the intermediate classes than was found in the Sebago x Katahdin cross. Selections were made from an earlier cross (No. 336, President x Katahdin) and all of these showed an intermediate type of resistance. One, 336-7, was backcrossed to President. In 1937 the mean for 256 seedlings of this backcross was 4.25 with more than half the seedlings showing an intermediate type of reaction. Other progenies, of which one or both parents was a selection from the 336 cross, were tested at various times. In every case a number of seedlings were produced that had an intermediate type of resistance, but very few showed more resistance than the President. The cross Ackersegen x 336-18, which was tested in 1937, was an ex-

TABLE 2—*Reactions of progenies related to Chippewa, Katahdin, Sebago, Ackersegen, and President in late blight tests at Presque Isle, Maine. President and Green Mountain checks are included for comparison.*

Pedigree Number	Parentage	Year	Seedlings Tested	Check Plots	Seedlings and Checks in Different Classes of Infection[1]								Mean	Standard Error of Single Plot
					1	2	3	4	5	6	7	8		
			No.	No.	No.	No.	No.	No.	No.	No.	No.	No.		Class
X 810	Ackersegen x 336-18	1937	859	...	0	140	442	208	53	15	0	1	3.26	0.88
X 462	President x 336-7	1937	256	...	0	2	21	157	63	13	0	0	4.25	.71
X 793	Russet Rural x 336-7	1937	584	...	0	0	2	68	188	249	46	31	5.62	.98
X 735	Sebago x 336-18	1937	163	...	0	0	13	68	63	16	1	2	4.57	.89
I 438	336-7 selfed	1937	63	...	0	0	8	38	9	7	1	0	4.29	.89
I 456	336-18 selfed	1937	238	...	0	0	55	120	46	15	1	1	4.12	.88
	President	1937	...	257	0	0	82	175	0	0	0	0	3.68	.47
	Green Mountain	1937	...	299	0	0	0	0	0	233	53	13	6.26	.53
X 123	336-7 x 336-18	1938	265	...	0	1	16	128	68	41	4	7	4.65	1.04
X 811	336-123 x 336-18	1938	392	...	0	0	28	140	125	77	6	16	4.85	1.12
X 114	336-184 x 336-18	1938	94	...	0	0	11	51	20	2	0	1	4.28	.78
X 644	336-302 x Katahdin	1938	209	...	0	0	2	39	57	37	21	53	5.93	1.49
X 653	336-302 x 46197	1938	322	...	0	0	0	20	94	73	42	93	6.29	1.32
	President	1938	...	84	0	0	11	73	0	0	0	0	3.87	.35
	Green Mountain	1938	...	84	0	0	0	0	0	0	0	84	8.00	.00
X 1128	Ackersegen x 336-7	1939	190	...	0	0	0	1	3	4	1	181	7.88	.55
X 1274	Chippewa x Katahdin	1939	249	...	0	0	2	22	23	24	11	167	7.09	1.44
X 1272	Sebago x Katahdin	1939	280	...	0	1	22	53	81	31	16	76	5.68	1.69
X 1273	do x Earlaine	1939	203	...	0	0	3	16	23	10	3	148	7.16	1.47
N.P. 1	336-144 Nat. Pollinated	1939	188	...	0	0	5	14	74	60	20	15	5.64	1.11
I 1345	336-153 selfed	1939	148	...	0	0	5	22	70	39	7	5	5.24	.99
I 1346	336-179, do	1939	158	...	0	0	2	8	48	27	6	67	6.44	1.47
I 1303	47454[2]	1939	74	...	0	0	15	18	23	13	0	5	4.73	.13
	President	1939	...	129	0	0	72	57	0	0	0	0	3.44	.50
	Green Mountain	1939	...	161	0	0	0	0	0	0	0	161	8.00	.00
B 42	Earlaine x 336-144	1940	758	...	0	0	2	31	74	262	27	362	6.80	1.26
B 30	Houma x 336-144	1940	466	...	2	0	0	0	21	118	49	276	7.22	1.06
B 34	Sebago x Ostragis	1940	138	...	0	0	16	10	26	59	3	24	5.69	1.47

[1]For class descriptions, see table 1.
[2]Selection from Ackersegen x Katahdin.

B 34	Sebago x Ostragis	1940	138	...	0	0	16	10	26	59	3	24	5.69	1.47

[1]For class descriptions, see table 1.
[2]Selection from Ackersegen x Katahdin.

TABLE 2—*Reactions of progenies related to Chippewa, Katahdin, Sebago, Ackersegen, and President in late blight tests at Presque Isle, Maine. President and Green Mountain checks are included for comparison—(Continued).*

Pedigree Number	Parentage	Year	Seedlings Tested	Check Plots	Seedlings and Checks in Different Classes of Infection[1]								Mean	Standard Error of Single Plot
					1	2	3	4	5	6	7	8		
			No.	No.	No.	No.	No.	No.	No.	No.	No.	No.		Class
B 36	do x 336-144	1940	436	...	1	0	15	44	68	208	15	85	5.95	1.32
B 43	336-144 x Earlaine	1940	610	...	0	0	2	22	56	207	24	299	6.85	1.24
	President	1940	...	39	0	0	0	0	0	1	3	35	7.87	.40
	Green Mountain	1940	...	41	0	0	0	0	0	0	4	37	7.90	.32
B 33	41956 x 336-144	1941	556	...	0	1	2	30	49	144	167	163	6.67	1.18
S. I.	Sebago selfed	1941	83	...	0	0	0	0	5	17	29	32	7.06	.92
	President	1941	...	20	0	0	0	1	13	6	0	0	5.25	.56
	Green Mountain	1941	...	80	0	0	0	0	0	4	21	55	7.64	.57
B 164	Sebago x 245-25	1942	257	...	0	0	0	5	19	97	94	42	6.58	.92
	President	1942	...	38	0	0	0	0	1	33	4	0	6.08	.37
	Green Mountain	1942	...	41	0	0	0	0	0	0	11	30	7.73	.45
	President	1943	...	36	0	1	8	26	1	0	0	0	3.75	.56
	Green Mountain	1943	...	36	0	0	0	0	0	3	16	17	7.39	.65
B 282	Green Mt. x 336-144	1944	121	...	0	0	0	20	46	46	2	7	5.42	.98
B 296	Houma x do	1944	88	...	0	0	1	9	24	44	6	4	5.65	.96
B 275	President x Katahdin	1944	165	...	0	0	14	20	42	84	2	3	5.30	1.05
B 274	do x 47156	1944	135	...	0	0	1	9	48	72	4	1	5.53	.73
B 311	Sebago x 46952	1944	71	...	0	0	0	1	12	30	12	16	6.42	1.06
B 434	46952 x 336-144	1944	147	...	0	0	6	20	24	70	14	13	5.71	1.20
	President	1944	...	38	0	0	0	5	30	3	0	0	4.95	.46
	Green Mountain	1944	...	37	0	0	0	0	0	34	3	0	6.08	.28
	Total seedlings	....	8,966	...	3	145	711	1,412	1,654	2,211	634	2,196	5.76	
	Do President checks	....	...	641	0	1	173	337	45	43	7	35	4.18	
	Do Green Mountain	....	...	779	0	0	0	0	0	274	108	397	7.16	

[1]For class descriptions, see table 1.

TABLE 3—*Reactions of progenies related to the German "W" races. President and Green Mountain checks are included for comparison.*

Pedigree Number	Parentage	Year	Seedlings Tested	Check Plots	Seedlings and Checks in Different Classes of Infection[1]								Mean	Standard Error of Single Plot
					1	2	3	4	5	6	7	8		
			No.	No.	No.	No.	No.	No.	No.	No.	No.	No.		Class
....	3895-13 Nat. Pollinated	1937	15	..	0	4	2	3	0	1	1	4	4.73	2.49
X 96	3895-13 x Earlaine	1937	450	..	0	10	36	58	64	106	54	122	5.93	1.71
X 444	3895-13 x Katahdin	1937	37	..	0	1	5	16	12	2	1	0	4.32	.97
N.P. 13	3897-90 Nat. Pollinated	1937	51	..	4	23	7	7	0	1	0	9	3.47	2.32
X 453	3897-90 x 336-18	1937	59	..	0	3	7	16	21	11	0	1	4.58	1.17
	President	1937	..	257	0	0	82	175	0	0	0	0	3.68	.47
	Green Mountain	1937	..	299	0	0	0	3	0	233	53	13	6.26	.53
X 698	3897-90 x 336-18	1938	243	..	0	23	48	60	43	45	4	20	4.54	1.64
	President	1938	..	84	0	0	11	73	0	0	0	0	3.87	.35
	Green Mountain	1938	..	84	0	0	0	0	0	0	0	84	8.00	.00
X 96	3895-13 x Earlaine	1939	41	..	0	0	0	0	0	0	0	41	8.00	.00
	President	1939	..	129	0	0	72	57	0	0	0	0	3.44	.50
	Green Mountain	1939	..	161	0	0	0	0	0	0	0	161	8.00	.00
X 96	3895-13 x Earlaine	1940	9	..	5	2	0	1	0	0	0	1	2.33	2.35
	President	1940	..	39	0	0	0	0	0	1	3	35	7.87	.40
	Green Mountain	1940	..	41	0	0	0	0	0	0	4	37	7.90	.32
X 918	3895-2 x Earlaine	1941	4	..	4	0	0	0	0	0	0	0	1.00	1.00
X 183	3895-2 x Earlaine	1941	31	..	17	0	0	3	0	0	0	11	3.77	3.30
X 96	3895-13 x Earlaine	1941	8	..	8	0	0	0	0	0	0	0	1.00	.00
X 194	4050-9 x Earlaine	1941	13	..	10	0	0	0	0	0	0	3	2.62	3.07
	President	1941	..	20	0	0	0	1	13	6	0	0	5.25	.56
	Green Mountain	1941	..	80	0	0	0	0	0	4	21	55	7.64	.57
B 69	Katahdin x 96-56	1942	37	..	3	9	3	1	0	0	5	16	5.32	2.90
B 65	Richter's Jubel x 96-56	1942	170	..	27	11	11	13	9	15	13	71	5.46	2.73
B 74	96-28 x 245-25	1942	95	..	20	8	8	9	3	8	11	28	4.84	2.80

TABLE 3—*Reactions of progenies related to the German "W" races. President and Green Mountain checks are*

TABLE 3—*Reactions of progenies related to the German "W" races. President and Green Mountain checks are included for comparison—(Continued).*

Pedigree Number	Parentage	Year	Seedlings Tested	Check Plots	Seedlings and Checks in Different Classes of Infection[1]								Mean	Standard Error of Single Plot
					1	2	3	4	5	6	7	8		
			No.	No.	No.	No.	No.	No.	No.	No.	No.	No.		Class
B 1019	96-28 selfed	1942	30	..	4	3	1	0	3	2	8	9	5.60	2.62
B 76	96-44 x 528-170	1942	294	..	80	38	7	7	10	18	29	105	4.78	3.05
B 1020	96-44 selfed	1942	35	..	0	0	5	4	4	4	4	14	6.14	1.91
B 1021	96-56 selfed	1942	29	..	4	14	4	2	1	0	1	3	3.03	2.13
B 1022	96-99 selfed	1942	5	..	1	2	0	0	0	0	1	1	4.00	3.24
B 1023	96-109 selfed	1942	30	..	25	2	0	0	0	0	0	3	1.77	2.13
B 77	96-140 x 528-170	1942	408	..	143	40	11	2	8	27	33	144	4.53	3.16
B 1024	96-140 selfed	1942	31	..	18	6	0	0	0	0	1	6	2.74	2.84
B 1025	96-345 selfed	1942	37	..	1	7	2	0	2	5	4	16	5.86	2.49
B 81	245-52 x 96-140	1942	547	..	244	39	3	2	4	13	40	202	4.27	3.30
	President	1942	..	38	0	0	0	0	1	33	4	0	6.08	.37
	Green Mountain	1942	..	41	0	0	0	0	0	0	11	30	7.75	.45
B 192	Earlaine 2 x 96-56	1943	22	..	5	2	1	1	0	4	0	9	5.09	2.99
B 193	Earlaine 2 x 96-345	1943	8	..	4	2	1	0	0	0	0	1	2.38	2.39
B 194	Earlaine 2 x 918-12	1943	16	..	8	0	0	0	1	2	0	5	4.06	3.28
B 188	Green Mt. x 96-56	1943	75	..	28	5	0	1	0	2	11	28	4.73	3.26
B 189	Green Mt. x 96-345	1943	24	..	9	4	0	0	0	1	2	8	4.21	3.44
B 190	Green Mt. x 918-9	1943	25	..	7	1	1	1	1	1	5	8	5.04	3.02
B 191	Green Mt. x 918-12	1943	46	..	12	4	0	1	2	6	7	14	5.02	2.94
B 174	Katahdin x 918-12	1943	32	..	13	0	1	2	8	4	2	2	3.69	2.47
B 176	Katahdin x 918-34	1943	13	..	2	0	2	0	6	2	0	1	4.46	1.98
B 179	Katahdin x 698-244	1943	26	..	9	0	1	4	7	4	0	1	3.65	2.17
B 173	Hindenburg x 918-12	1943	32	..	14	0	2	3	5	2	2	4	3.59	2.65
B 177	96-56 x Katahdin	1943	22	..	7	0	0	0	5	2	5	3	4.68	2.75
B 235	444-13 x 96-56	1943	21	..	14	2	0	0	1	1	2	1	2.43	2.46

TABLE 3—*Reactions of progenies related to the German "W" races. President and Green Mountain checks are included for comparison—(Continued).*

Pedigree Number	Parentage	Year	Seedlings Tested	Check Plots	Seedlings and Checks in Different Classes of Infection[1]								Mean	Standard Error of Single Plot
					1	2	3	4	5	6	7	S		
			No.	No.	No.	No.	No.	No.	No.	No.	No.	No.		Class
	President	1943	..	36	0	1	8	26	1	0	0	0	3.75	.56
	Green Mountain	1943	..	36	0	0	0	0	0	3	16	17	7.39	.65
B 294	Houma x 96-56	1944	88	..	10	20	7	4	3	14	7	23	4.76	2.66
B 287	Katahdin x 96-56	1944	20	..	1	5	0	0	1	3	1	9	5.65	2.72
B 273	President x 96-28	1944	132	..	46	21	2	2	11	36	7	7	3.62	2.49
B 313	Sequoia x 96-56	1944	96	..	15	24	7	4	1	25	9	11	4.23	2.49
B 227	Green Mt. x 96-44	1944	19	..	1	2	0	0	2	5	2	7	6.05	2.22
B 345	96-28 x 336-144	1944	25	..	9	0	1	0	6	6	0	3	4.08	2.58
B 351	96--44 x 336-144	1944	94	..	41	2	3	5	12	24	1	6	3.54	2.48
B 354	96-56 x Katahdin	1944	23	..	2	7	2	1	0	5	3	3	4.39	2.51
B 355	96-56 x 336-144	1944	91	..	18	28	4	1	5	16	9	10	3.89	2.55
	President	1944	..	38	0	0	0	5	30	3	0	0	4.95	.46
	Green Mountain	1944	..	37	0	0	0	0	0	34	3	0	6.08	.28
	Total seedlings	...	3,659	..	893	374	195	234	261	423	285	994	4.63	..
	Total President checks	...	641	..	0	1	173	337	45	43	7	35	4.18	..
	Total Green Mt. checks	...	779	..	0	0	0	0	0	274	108	397	7.16	..

[1]For class descriptions, see table 1.

ception to this rule. A number of seedlings in this cross showed more resistance than President. Ackersegen is more resistant than President, so the result is not surprising.

From the breeding standpoint many of these intermediate types could be considered commercially resistant, but none of the selections was found superior in other characters to Sebago, which is already in commercial production. Most of them were too late-maturing to be of value.

The seedlings related to the German *W* races, on the other hand, have contributed two characters of great importance to the breeding program; much higher type of resistance to late blight than was found in President and its relatives, and genes for early maturity. The late blight data of a relatively large number of progenies related to these races are given in table 3. The President and Green Mountain checks for each year are included for comparison. The selections made from the first introduction showed a high degree of resistance to late blight, but they were all low in yield and market quality. Some of these were crossed with Earlaine, Katahdin, and 336-18. A number of seedlings from the resulting progenies retained the blight resistance of the foreign parent (Table 3), and they were much more promising from the commercial standpoint. Selections from cross number 96 (3895-13 x Earlaine) were among the best. Some of these, such as 96-28, 96-44 and 96-56, are blight-resistant, early, and self-fertile. These have in turn been selfed, sib-mated, and out-crossed to various commercial varieties and promising seedlings, and it will be noted that regardless of the other parent a number of seedlings will be found in the resulting progenies in the first three classes of infection. The market quality of many of the resistant types is also high, so in recent years selections have been made for tuber type and vigor the first year the seedlings were grown in the field, and a relatively high percentage of the selections proved to be resistant to blight in subsequent tests.

From the breeding standpoint it is interesting to note that out of a total of 8,966 seedlings listed in table 2, 859, or about 10 per cent, were reported in the first three classes of infection, most of them being in class 3. On the other hand, when the seedlings related to the *W* races are considered as a whole, it is seen that out of a total of 3,659, 1,462, or approximately 40 per cent, are found in those classes, and most of these are in classes 1 and 2. It can be readily seen that the chances of producing a commercial variety with a high degree of resistance has been greatly increased by the introduction of the *W* races.

Correlation

A few years ago the idea was prevalent that lateness of maturity and resistance to late blight were related to such an extent that the production of an early blight-resistant type was improbable. A study of 1,278 seedlings from progenies that were segregating for early, medium, and late types and for resistance and susceptibility to late blight showed no significant correlation between time of maturity and resistance. The coefficient of correlation was 0.07.

Physiologic Races

In 1942 to 1944 a second reading on late blight infection was taken 2 to 3 weeks after the first reading. The second reading was made on the varieties that were free from late blight at the first reading. The results of these disclosed that many of the varieties that were blight-free at the first reading manifested an occasional blighted pustule at the second reading.

In 1943 and 1944 late blight cultures were made from representative varieties that apparently were immune from the common race of the late blight fungus used to infect the test plots and were used in comparative inoculations in the greenhouse. Ten cultures from ten varieties that are immune from the common late blight race were tested on 28 immune varieties, representing 15 crosses, and on Green Mountain. Comparable inoculations were made on these varieties with a culture of the common race of late blight, which was used to start the infection in the field test plots. Results of the greenhouse tests disclosed that each of the 10 cultures killed the 28 varieties, whereas the common-race culture failed to infect these varieties, which indicates that the 10 cultures represented a more virulent race or races than the common form. These results also indicate that the varieties rated in the tables as belonging in classes 1 and 2 and those with no infection or with only an occasional blighted leaf, are immune from the common races in both field and greenhouse tests. So far, however, only a slight infection with the more virulent races has been found on the resistant seedlings in the field tests, and that toward the end of the growing season. In the greenhouse tests, on the other hand, where the organisms are carefully cultured and the conditions are ideal for infection, severe injury results to all the varieties and seedlings so far tested.

Commercial Types

In recent years a number of seedlings have been selected that are highly resistant to blight and have other characters of economic importance. In 1944, 12 of these were included in a yield test at Presque

Isle, Maine. The data for yield, tuber density, season of maturity, and blight reaction of these seedling varieties are given in table 4. Similar data for 3 commercial varieties are given for comparison. One of the latter, Green Mountain, is a high-yielding, high-quality late variety very susceptible to late blight. Sebago is late, high-yielding, medium in quality and intermediate in type of resistance to late blight. Red Warba produced the highest yield of the early varieties in the 1944 tests. It has good cooking quality when grown on Aroostook Farm but is quite susceptible to blight. Occasionally, however, it escapes serious damage from this disease because it matures before the epidemic has reached a climax. The yield tests were sprayed with Bordeaux mixture so that the susceptible varieties were not at a disadvantage.

It is realized that one year's test is not conclusive, but the data indicate that some of the varieties that seldom show a pustule under the severest epidemics of the common forms of blight yield as high or higher than the Green Mountain or Sebago. B67-11, B70-5, B73-2, B73-10, B188-9, B188-61, and B192-17 are all in that class. It should be noted, too, that the tubers of several of these are about as high in dry-matter content as the Green Mountain, as is indicated by the number of the salt solution in which they were found to float. B67-11, B70-5, and B73-10 are among the best in this respect.

One of the most striking features of these experiments is that very early, early, medium-early, and late varieties have been produced that are highly resistant to blight and give satisfactory yields of tubers with relatively high dry-matter content. Further tests will have to be made to pick out the best of the group, but it will not be long before one or more of them is named and distributed to growers who suffer heavy losses from blight despite heroic efforts to prevent such losses by spraying. In fact, one of these, B70-5, has been tested for yield for two years. In 1943 it yielded 615 bushels of U. S. No. 1 tubers per acre, as compared with 499 for Sebago, and in 1944 it again outyielded Sebago significantly, as is shown in table 4.

Discussion

The work of breeding for resistance to the common forms of late blight as summarized in this paper shows continued progress from the susceptible varieties with which the work was started through the intermediate classes of resistance represented by the President variety to the immunity characteristic of the *W* races. The origin of these races is somewhat obscure as only the immediate pedigrees were received from

TABLE 4—*Yield, tuber density, and maturity of a number of blight-resistant selections related to the W races. Grown at Presque Isle, Maine, 1944. Three commercial varieties are given for comparison.*

Variety	Parentage	Yield per Acre		Salt Solution[1]	Maturity[2]	Blight Reaction[3]
		U. S. No. 1	U. S. No. 1			
		Bushels	Per cent			Class
Green Mountain		364 ± 16	98	6.1 ± 0.37	L	8
Sebago	Chippewa x Katahdin	308 ± 16	97	3.1 ± 0.37	L	5
B 61-3	96-56 x 528-170	272 ± 17	97	5.1 ± 0.41	L	1
B 69-12	Katahdin x 96-56	203 ± 16	98	3.9 ± 0.37	L	1
B 70-5	B 127 x 96-56	375 ± 17	99	5.0 ± 0.41	L	1
B 73-2	Mohawk x 96-56	358 ± 16	99	4.8 ± 0.37	L	1
B 73-18	Mohawk x 96-56	281 ± 16	99	5.7 ± 0.37	L	1
B 174-5	Katahdin x 918-12	278 ± 16	98	2.1 ± 0.37	L	1
B 188-9	Green Mt. x 96-56	333 ± 16	99	4.4 ± 0.37	L	1
B 188-61	Green Mt. x 96-56	436 ± 16	99	4.8 ± 0.37	L	1
B 188-69	Green Mt. x 96-56	311 ± 16	97	5.5 ± 0.37	L	1
B 67-11	627-213 x 96-56	350 ± 17	99	6.9 ± 0.41	M	1
B 73-10	Mohawk x 96-56	344 ± 17	99	5.6 ± 0.41	M	1
B 235-16	444-13 x 96-56	256 ± 17	97	4.3 ± 0.41	M	1
Red Warba	Sport of Warba	325 ± 8	98	5.6 ± 0.20	E	8
96-44	3895-13 x Earlaine	285 ± 8	97	5.9 ± 0.20	E	1
96-56	3895-13 x Earlaine	306 ± 8	98	6.3 ± 0.20	E	1
B 75-4	47562 x 96-28	256 ± 17	99	5.5 ± 0.41	E	1
B-177-14	96-56 x Katahdin	253 ± 17	99	5.2 ± 0.41	E	1
B 192-17	Earlaine No. 2 x 96-56	356 ± 17	99	4.1 ± 0.41	EE	1

[1]Salt Solution

Number	Specific Gravity	Starch Equivalent
1	1.060	9.5
2	1.065	10.7
3	1.070	11.7
4	1.075	12.9
5	1.080	13.9
6	1.085	14.9
7	1.090	16.1

[2]Maturity Classes
L = late
M = medium
E = early
EE = very early

[3]For description of blight classes see table 1.

K. O. Müller with the seed, and these do not indicate the source from which the blight resistance was acquired. A statement found in a translation of an article by Rybin (8) is of interest here. He said: "At the present time Müller in crossing cultivated (selected) potatoes with native South American varieties has obtained forms which are highly resistant to *Phytophthora*. With regard to the South American forms used in these crosses Müller gives only very incomplete data. They were obtained in 1912 by Broili from Wittmack who in his turn obtained them from the Washington Department of Agriculture. They were designated in the works of Broili and Müller under the conditional name of the Washington Assortment S. W. These plants were used by Broili in crossing with European varieties, but at the present time neither tubers nor morphological description of these forms exist."

The genetic interpretation of the data is made somewhat difficult not only because of the tetraploid nature of the cultivated forms of the potato but because of factors other than genetic that affect the results; such as the effects of seasonal conditions, which determine the time at which it is possible to create an epidemic, the injurious effects of other diseases and insects, and the season of maturity of the seedlings, some of which may ripen before the disease has developed serious proportions. So far physiologic forms or increase of virulence have not complicated the program, but they may enter the picture later on and make the problem even more difficult than it is at present.

That the mode of inheritance is not too complicated is indicated by relatively large numbers of resistant segregates being found in rather small populations. This is the factor of greatest importance in a potato breeding program. In recent years late blight has caused considerable losses in nearly all the important potato-producing areas, and because resistance to this disease is not difficult to combine with other characters of economic importance most of the new varieties of the future should be as nearly immune to blight as possible.

Summary

The present program of breeding potato varieties resistant to late blight (*Phytophthora infestans* (Mont.) D By.) was begun twelve years ago by the United States Department of Agriculture in cooperation with the Maine Agricultural Experiment Station. Several reports of progress have been published, and the present paper brings the results up-to-date and discusses some of the newer family lines and potential commercial selections.

Varieties showing various reactions to late blight, from complete susceptibility to immunity to the common forms, have been used as parents in this project. A few seedlings with an intermediate type of resistance were produced by crossing two susceptibles. A much larger percentage of intermediates were produced when intermediates such as President and its relatives were used as parents of selfed lines and crosses. The intermediates from this series of progenies were all late, and none of them was superior in other characters to Sebago. Selections from the original introductions of the *W* races from Germany showed a high degree of resistance to late blight, but they were all low in yield and market quality. When some of these were crossed with American varieties and seedlings a number of selections from the resulting progenies retained the blight resistance of their foreign parents, but they were much more desirable from the commercial standpoint. A number of these selections were in turn selfed- sib-mated, and outcrossed to various commercial varieties and promising seedlings. From this second series of progenies selections have been made that are highly resistant to late blight, and in preliminary trials show yields and dry-matter content of the tubers equal to the best commercial varieties grown in Maine. Some of these are very early, others early, and still others late. In several progenies segregating for both characters no significant correlation was found between season of maturity and resistance to late blight. It should not be long before one or more of the most resistant of these seedling varieties is named and distributed to growers who at present suffer severe losses from late blight despite attempts to control the disease.

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SECTIONAL NOTES

CONNECTICUT

The stand is very uneven in Connecticut. The exceptionally warm period during April advanced the planting of some fields whereas the unusually cool, wet May greatly delayed the planting of many others. The results are that those planted early on well-drained soils are ahead of normal but the reverse holds for the late-planted. The acreage which failed completely, because of wet soils, is not large, —probably not more than 1 per cent. Rather poor stands prevail on many of the late-planted fields.

There appears to be an abnormally large percentage of degenerative diseases, especially leaf-roll, this year. No doubt, this situation reflects the difficulties of controlling these troubles in the seed-producing regions.

Serious magnesium deficiency has been found in the potatoes of several large growers and also on experimental plots. This is the first season that any appreciable amount of magnesium deficiency has been noted by the writer. It is associated with strongly acid soils, the omission of magnesium in the fertilizers and failure to apply any dolomitic limes, to potato fields. The far above average precipitation of April, May and June has leached the small amounts of soluble magnesium below the reach of the young potato plants. (July 14) B. A. BROWN.

NEBRASKA

The planting of potatoes in western Nebraska for the main crop has finally drawn to a close. After an extended rainy spell which delayed the beginning of planting until after the 10th of June, the work was interrupted by several downpours,—on ground already saturated. The weather has remained cool, which is ideal for the establishment

of the new plants, but certainly does not favor corn. In fact there have been but a few warm days to date.

The final acreage of all potatoes planted, results in an increase when compared with the plantings of a year ago. It is estimated that the increase will vary from 15 to 20 per cent. The increase is greatest in the dry land counties throughout the Panhandle area, which suffered such severe drought between 1934 and 1938, and where the acreage had shrunk to practically nothing at the beginning of this decade.

As usual, practically 95 per cent of the planting is comprised of the Triumph variety. The Kasota, a variety introduced jointly by the Minnesota and Nebraska Experiment stations, and named a year ago, is increasing in popularity. It shows not only definite merit in its resistance to Fusarium wilt, but also produces good quality under adverse conditions. The Russet Rural which shows scab resistance, is gaining favor in areas where scab is troublesome. The Katahdin and Chippewa are going out of production, as being less well adapted, and not being able to compete with the red-skinned varieties, Triumph and Kasota. In the same category, the Red Warba is coming into its own for seed purposes, being the favorite variety in Central and Eastern Nebraska.

The crop in Central and Eastern Nebraska made a good "recovery" from a poor beginning. Our harvesting operations will begin this coming week. In contrast with a year ago,—when a severe hopper infestation reduced our yields one-half,—excellent yields are now in prospect. Naturally, ceiling prices are expected. (July 13)—MARX KOEHNKE.

NEW JERSEY

Many New Jersey potato growers started to harvest their cobblers the first week of July and approximately 5 per cent of the crop has been harvested to date. Our yields have been quite variable, —ranging from 75 to 170 sacks per acre. The quality is generally good but the tuber size is relatively small because of the rather heavy set. At present, prices are at ceiling and the demand is strong.

To date late blight has been found in relatively few fields and very little tuber rot is anticipated from this cause.

Extensive rains have fallen during the past two weeks and in some local areas considerable washing and flooding have occurred. These rains have been very beneficial for the Katahdin crop which has shown no signs of ripening as yet. (July 17)—J. C. CAMPBELL.

NEW YORK

The condition of the potato crop in upstate New York is extremely variable. Stands are below normal and the size of the plants varies greatly with the date of planting. In Steuben County one observes that a considerable acreage planted in early May is in excellent condition,—the plants being almost fully grown and now in full bloom. In immediately adjoining fields, one may see potatoes just breaking ground. Those planted earliest look best. Apparently the principal difficulty with stands this year is due to the unseasonably warm weather in March which caused potatoes in damp storage to develop a rosette type of sprout. Many of this type of seed piece failed to develop a plant but instead daughter tubers near the eyes. This situation seems almost universal outside of Long Island. A considerable acreage was not planted until very late in June. What develops from these latest plantings will depend on the length of season available. Right now the soil moisture situation is generally very favorable. The crop is making an excellent growth. The first two weeks in July have given us abnormally cool weather which may have started blight in a few areas. Blight was, in fact, reported in Onondaga County this week.

The Long Island potato crop has made excellent growth and the prospects point to one of the best crops that our Long Island growers have ever experienced. Harvesting has already begun in Nassau County.

One of the items of greatest concern at present now is the lack of trucks available for handling the crop. Several Steuben County growers, each with over one hundred acres of potatoes, have the unpleasant prospect of handling the 1945 crop with one truck and this of questionable durability. This situation may be more serious than any one now realizes. Labor camps for the potato harvest are being organized throughout the principal potato counties. There is some concern concerning housing facilities for this transient labor, but the prospective supply of seasonal labor seems to be favorable. The big growers apparently have increased their acreage this year and are doing a wonderful job of food production. Any failure to produce the maximum of potatoes this year will be the result of unfavorable weather and also lack of available equipment. (July 14)—E. V. HARDENBURG.

OHIO

Ohio had a very wet cool spring. The rainfall for April and May was above normal. June was also cool with ample rain. The early potato crop shows better prospects than it has for several years.

The planting of the late crop was later than usual because of the wet weather but the plantings have been completed for nearly two weeks.

During the past two weeks the weather has been warmer and the rainfall less. In fact, some parts of the state need rain at the present time.

The leafhopper population is exceedingly heavy and potatoes are showing the effect of this infestation because spraying was delayed on account of the weather. On experimental plots DDT is showing excellent control of leafhoppers.

Our potato supply in the Ohio market is very limited and most retailers are limiting their sales to consumers. There are a few local potatoes being harvested along the Ohio River, but local supplies will be light for the next two weeks.

We anticipate that our potato yields will be considerably higher than those of last year, at which time the serious drought cut the crop approximately 50 per cent. (July 10)—Earl B. Tussing.

PENNSYLVANIA

Planting has been late in the northern part of the state, as a result of heavy rains and the acreage may be cut slightly in this area. In the southern part of the state the vines are large for this time of year. Considerable loss has occurred from black leg, especially on the Sebago variety. Most fields, however, show only two to three per cent but occasional fields that have been visited show approximately twenty-seven per cent affected plants. As yet, late blight occurrence has not been confirmed, although it has been reported in Pennsylvania. Many farmers have confused leaf scorch resulting from excessive heat, with late blight. (July 2)—O. D. Burke.

VIRGINIA

Because of the unseasonably warm weather in March, cold weather in April, dry weather in May and wet weather during the latter half of June, the potato crop has been variable in yield depending upon when the tubers were planted. Potatoes that were emerging when cold weather occurred in April were injured on lighter soils, that is on soils having a low heat capacity. A condition known as "brown sprout" occurred in which the sprout, the terminal bud, and most of the roots turned light brown. In some cases new sprouts were produced, but yields on the 3 to 5 per cent of the area affected with "brown sprout" were extremely low. On some early planted areas, because of the warm March and the cool April weather, the plants set a heavy crop of tubers

which matured early because of the drought in May. However, the yield on such areas was considerably higher than in 1944 being approximately 50 to 70 bags to the acre. In other areas, particularly in the northern part of the Eastern Shore section, the potatoes were planted enough later to avoid the warm weather in March and also to be benefited by the cool weather in April and the wet weather in June. In these areas, as well as on irrigated farms, yields approached 200 bags per acre. Over the area as a whole, on certain farms, virus troubles and particularly what appeared to be "purple top wilt" reduced yields 30 to 40 per cent. Digging in northern Accomac County will be practically completed by the 20th of July. The yield in the area, as a whole, will average 20 to 25 per cent higher than last season. (July 13th).—R. L. CAROLUS.

LONG ISLAND

In some sections of Long Island the very hot weather during the middle of June very seriously hurt potatoes, especially those of the Cobbler variety grown on the lighter soils.

Chippewas and Green Mountains which constitute the major parts of our varieties, were not seriously injured and now show promise of a very good yield. At the present time there is ample moisture, but more rain will be needed to carry the crop to maturity.

Cobblers are now being harvested and some very good yields are being obtained, especially in the Orient and Southold sections. This section of the Island is very narrow, with large bodies of cold salt water on each side, which help prevent the extreme heat that caused damage in other sections.

Blight is quite general but to this date has not been serious enough to do any damage. (July 9)—H. R. TALMAGE.

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POTATO VARIETIES: THE NEWLY NAMED, THE COMMERCIAL, AND SOME THAT ARE USEFUL IN BREEDING

DONALD FOLSOM

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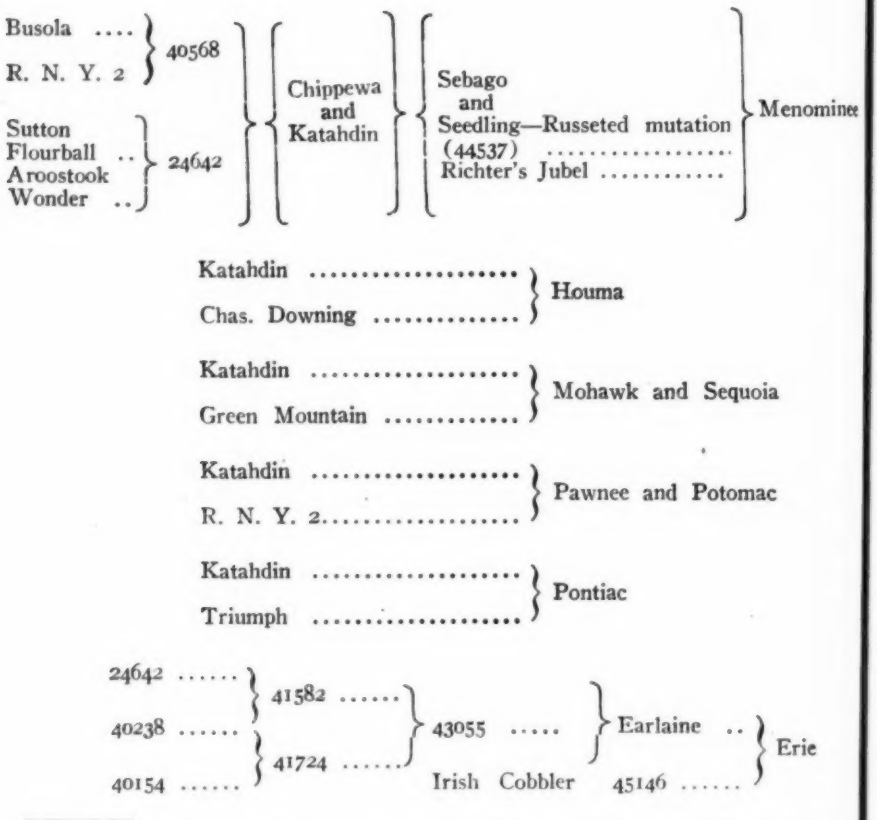
Interest is frequently expressed in the origin, history and characteristics of the newer varieties of potatoes. Information on these varieties is available in numerous publications. It was thought worth while to compile in one article selected data on the most important of these and certain other commercial and breeding varieties. The list includes some recently introduced varieties, the older varieties that are still commercially important in the West in 1940 (10)[1], in the South in 1942 (21), or in the North in 1944 (22), and some varieties (European, old U. S., and seedling) that are prominent in the parentage of the two preceding groups or that are otherwise specially interesting to the plant breeders.

The U. S. D. A. seedling numbers of certain recently introduced varieties are:

401-23 =Pontiac
528-118=Menominee
42667 =Katahdin
42672 =Chippewa
44428 =Golden
44488 =Sebago
44639 =Houma
45075 =Earlaine
46000 =Mohawk
47101 =Erie
B247 =Potomac
CS-1608=Pawnee

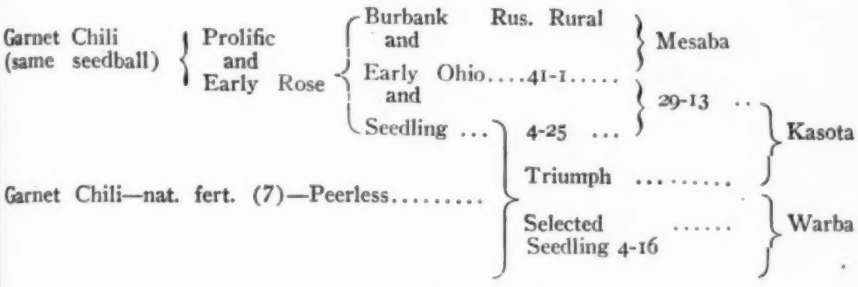
[1]Numbers in parentheses refer to literature cited.

Some seedlings appear more prominent in the pedigrees than do others, as for instance U.S.D.A. 24642. This seedling is resistant to mild mosaic (34) and immune to aphid transmission of virus A (30). As may be seen from the pedigrees of varieties given below, it came from a cross of Aroostook Wonder and Sutton Flourball and enters into the parentage of Chippewa and Katahdin, Sebago, Menominee, Houma, Mohawk and Sequoia, Pawnee and Potomac, Pontiac, Earlaine, Erie, and Golden. The extensive use of 24642 and Katahdin as parents may be seen in the following combinations of pedigrees:[2]



[2]The arrangement of names is not intended to indicate which is the pollen variety in any cross.

The important use of Garnet Chili as a parent may be seen in the following combination of pedigrees:



Named Varieties[3]

American Giant. (See Aroostook Wonder and White Rose.)

Aroostook Wonder. *Origin*: This variety is said (38) to have been in Maine before 1908. It is also said (39) to be the same as American Giant which originated in New York before 1881. The variety Aroostook Wonder enters into the parentage (see pedigree combinations above) of Chippewa and Katahdin, Sebago, Menominee, Houma, Mohawk and Sequoia, Pawnee and Potomac, Pontiac, Earlaine, Erie and Golden.

Bliss Triumph. (=Triumph (39).)

Brown Beauty. (=Prolific (7, 10).)

Burbank. *Origin*: In 1873 by Luther Burbank (38). It is a seedling of Early Rose (38, 39). (See pedigree combination from Garnet Chili, above.) It is grown in the West (10) and in the South (21).

Busola. This variety was obtained by the U. S. D. A. from Russian Poland in 1914 (according to a letter from F. J. Stevenson). It enters into the parentage (see pedigree combination on page 2) of Chippewa and Katahdin, Sebago, Menominee, Houma, Mohawk and Sequoia, Pawnee and Potomac, Pontiac, Earlaine, Erie, and Golden.

Charles Downing. (See Idaho Rural.) *Origin*: In Vermont, 1887 (38, 39). It enters into the parentage of Houma. It is grown in the West (10).

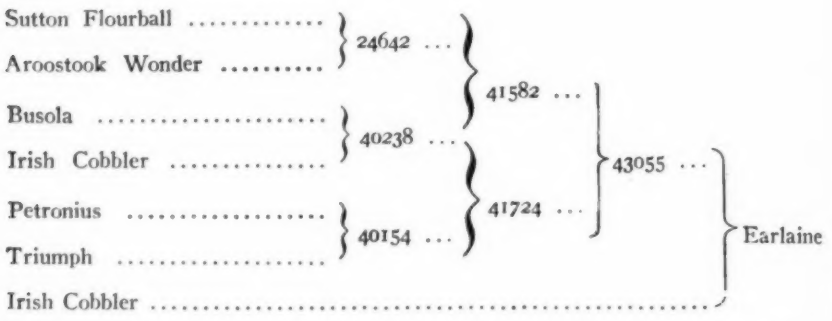
Chippewa. *Origin*: U. S. D. A. (42672), 1923 (5). *Pedigree* (5): See pedigree combination on page 230. It is resistant to

[3]For detailed descriptions see the various references including the general ones by Davidson (8), Jehle and McPheeters (14), Lombard and Bailey (22), Salaman (26), Stevenson *et al.* (31, 32, 33, 34), and Stuart (38, 39). and tables 1 and 2 compiled mostly from these sources.

mild mosaic (5, 22, 33), virus Y (15), and net necrosis (22, 36). Chippewa is popular for potato chips and french fries (22). It enters into the parentage of Sebago and Menominee. It is named after a tribe of Indians who occupied the region from Lake Huron to North Dakota (5).

DAKOTA RED. (See JERSEY REDSKIN). *Origin*: In Vermont from Pringle's hybrid seed (38), before 1883 (38, 39). It is grown in the South (21).

EARLAINE. *Origin*: U. S. D. A. (45075), 1930 (4). *Pedigree* (4):



Earlaine is field-resistant to mild mosaic (22, 33) and immune to aphid transmission of virus A (30). It enters into the parentage of Erie and of leafroll-resistant seedlings (36). The name is a contraction of the words "early" and "Maine" (4).

EARLAINE NO. 2. *Origin*: Seedling tubers of this variety were obtained by a farmer from the U. S. D. A. without the latter knowing of it at the time. (33).

EARLY OHIO. *Origin*: 1871, as a seedling of Early Rose (38, 39). (See pedigree combination from Garnet Chili, above.) It is grown in the North (22). It enters into the parentage of Kasota, Mesaba, and Warba.

ERIE. *Origin*: U. S. D. A. (47101), 1936 (3). *Pedigree* (3): See pedigree combination on page 2. Its name was selected on account of the expected adaptability of the variety to a region adjoining Lake Erie (3).

FLOURBALL. *Origin*: In England, 1895 (8). It is resistant to leafroll (26). It enters into the parentage (see pedigree combination on page 2) of Chippewa and Katahdin, Sebago, Menominee, Houma, Mohawk and Sequoia, Pawnee and Potomac, Pontiac, Earlaine, Erie and Golden.

TABLE I. *Some tuber and strout characteristics of the*

TABLE 1. *Some tuber and sprout characteristics of the newer varieties.*

Variety	Color	Skin	Shape	Eyes	Sprouts in Dark
Chippewa	White	Smooth	Elliptical to oblong; medium thick	Shallow	Creamy white
Earlaine	White	Smooth to slightly flaked	Round, flat, thick	Medium shallow to shallow	Creamy white
Earlaine No. 2	Like Earlaine		Like Earlaine	Deeper than Earlaine	
Erie	White	Smooth	Spherical	Moderately deep	
Golden	White	Smooth	Round	Medium shallow. Terminal one pale rose purple	White
Houma	White	Smooth	Short, thick	Shallow to medium deep	Pale purple
Kasota	Medium red	Smooth	Roundish, medium thick	Shallow	Somewhat red at tips
Katahdin	White	Very smooth	Roundish, medium thick	Shallow, few basal	Pale lilac
Menominee	White[a]	Slightly flaky to moderately russet	Round, medium thick	Medium deep	Rose purple
Mesaba	White	Smooth to slightly flaky	Round, thick	Shallow	Tip faintly reddish

TABLE I (*continued*). *Some tuber and sprout characteristics of the newer varieties.*

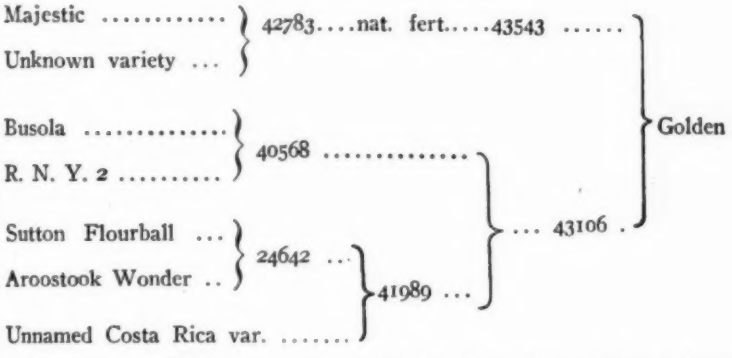
Variety	Color	Skin	Shape	Eyes	Sprouts in Dark
Mohawk	White[a]	Flaky to smooth	Elongated, thick	Shallow	Somewhat violet
Pawnee	White	Smooth	Roundish, medium thick	Shallow, very few	
Pontiac	Red	Smooth[a]	Round, thick	Medium deep	
Potomac	White	Smooth[a]	Round		Trace of pink
Sebago	White	Smooth	Nearly round, medium thick	Shallow	
Sequoia	White	Smooth to slightly russeted	Roundish, thick	Shallow	Creamy white
Warba	Creamy white except for pink eyes			Deep	

[a]According to a letter from F. G. Stevenson.

FRISCO. This was secured from Holland (2). It is immune to ring rot (2) and resistant to leafroll (34).

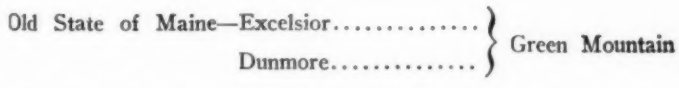
GARNET CHILI. *Origin*: New York, 1853 (38). It is a seedling of Rough Purple Chili (38, 39). It enters into the parentage of Prolific, Early Rose, Burbank, Early Ohio, Triumph, Kasota, Warba, and Mesaba. (See pedigree combination above.)

GOLDEN. *Origin*: U. S. D. A. (44428), 1928 (5). *Pedigree* (5):



The name probably was suggested by the color of the tuber flesh.

GREEN MOUNTAIN. *Origin*: In Vermont, 1878 (38, 39). *Pedigree* (38, 39):



It is grown in the South (21) and in the North (22). It enters into the parentage of Mohawk and Sequoia. The name probably was derived from the Green Mountain Range in Vermont.

HARMONY BEAUTY. *Origin*: In 1880 at Harmony, Maine, from a seedball of unknown parentage, being known at first as Mitchell (23). It is still grown extensively in central Maine where leafroll is prevalent and spreads rapidly each season.

HOUMA. *Origin*: U. S. D. A. (44639), 1929 (6). *Pedigree* (6): See pedigree combination on page 230. It is resistant to mild mosaic (22, 32, 33), yellow dwarf (22), and net necrosis (33). It rivals Green Mountain for cooking (22). The name is that of a place in Louisiana (6, 31).

IDAHO RURAL. (=CHARLES DOWNING (39).) It is grown in the West (10).

IMPERIA. This is a Swedish variety (27). It is resistant to leafroll (34). It enters into the parentage of leafroll-resistant seedlings (36).

IRISH COBBLER. This is a sport of Early Rose found about 1876 (39). It is grown in the West (10), in the South (21), and in the North (22). It enters into the parentage of Earlaine and Erie.

JERSEY REDSKIN. (=DAKOTA RED (21).) (Probably =Crimson Beauty renamed (9).)

KASOTA. *Origin*: Minnesota and Nebraska, 1934 (20). Pedigree (20):

Silverskin .....
Keeper ..... —4—selfed....4-25.. 29-13.... Kasota
Early Ohio seed 41—selfed....41-1.....
Triumph.

It is resistant to *Fusarium solani* v. eumarti (20), and somewhat resistant to late blight (20). The name (20, 22) is an Indian word for a clearing, but was selected as a combination of the last syllable of "Nebraska" and the last part of "Minnesota."

KATAHDIN. *Origin*: U. S. D. A. (42667), 1923 (5, 7). *Pedigree* (5, 7): See pedigree combination on page 230. It is resistant to mild mosaic (5, 7, 28, 29, 32, 33), immune to aphid transmission of virus A (30), resistant to latent mosaic (28, 29), resistant to virus Y (16), resistant to yellow dwarf (22), and resistant to net necrosis (33, 36). It enters into the parentage of Sebago, Menominee, Houma, Mohawk and Sequoia, Pawnee and Potomac, and Pontiac. Its name is the Indian name for the highest mountain in Maine (5, 7).

KEPPLESTONE KIDNEY. This is grown in Great Britain (8). It enters into the parentage of leafroll-resistant seedlings (36).

MCCORMICK. *Origin*: Indiana (38) in 1882 (38, 39). It is grown in the South (21).

MENOMINEE. *Origin*: U. S. D. A. (528-118), 1935 (40). *Pedigree* (40): See pedigree combination on page 230. It is resistant to scab and late blight (40). The name is that of an Algonquian tribe of Indians who have lived near the Menominee River which is between Wisconsin and Michigan, northwest of Lake Michigan (40).

MESABA. *Origin*: Minnesota A. E. S. and U. S. D. A., before 1933 (17). Pedigree (17):

Russet Rural .....
Early Ohio.....41-1..... Mesaba

TABLE 2. *Some plant characteristics of the newer varieties*

Variety	Duration	Habit	Stem Internode Color	Leaves	Flowers
Chippewa	Medium late	Medium to large, spreading	Slightly reddish purple	Long, broad, with terminal leaflet often lobed	Lilac with white tips
Earlaine	Early	Medium, somewhat spreading	Green	Medium long and wide	White
Earlaine No. 2	Midseason	Somewhat sprawling	Basal faintly purple	Light green, flat	White
Erie	Medium late		Light green	Light green	White
Golden	Late	Large, spreading	Slightly reddish purple	Medium wide and long	White
Houma	Midseason to late	Vigorous, medium to large, erect to spreading	Green to faint purple	Long, broad, flat, light green	White, many
Kasota	Midseason	Medium to large, compact	Reddish	Medium long, broad, dark green	Light lavender
Katahdin	Medium to late	Medium to large, spreading	Green or slightly reddish purple	Long, broad, flat, dark green	Light lilac
Menominee	Late	Medium to large, upright	Slightly reddish purple	Long, narrow	Large, medium lilac tips

TABLE 2 (*continued*). *Some plant characteristics of the newer varieties*

Variety	Duration	Habit	Stem Internode Color	Leaves	Flowers
Mesaba	Early	Medium large, erect compact	Reddish	Somewhat rugose; medium long, broad	Pale lilac, very small
Mohawk	Midseason to late	Like Green Mountain		Like Green Mountain	White with pink tips
Pawnee	Medium early	Medium, spreading	Purplish	Long, medium broad	Petunia violet
Pontiac	Late	Vigorous upright		Large, dark green, rough textured	
Potomac	Late	Vigorous, upright	Vigorous, upright[a]		
Sebago	Late	Vigorous, large, upright	Reddish purple	Medium long, broad, open, dark green	Lilac, many
Sequoia	Late	Very vigorous, large, erect	Green	Medium	White
Warba	Early				Light pink to lavender, sparse

[a]According to a letter from F. G. Stevenson.

(See also pedigree combination from Garnet Chili above.) The name probably was derived from that of the Masabi Mountains, the highest point in Minnesota, and is the name of a nearby town.

MOHAWK. *Origin*: U. S. D. A. (46000) before 1935 (13). *Pedigree* (13): See pedigree combination on page 230. It is resistant to mild mosaic (13, 22). The name is that of an Indian tribe formerly inhabiting what is now the Mohawk Valley in New York.

NETTED GEM. (=RUSSET BURBANK (10, 39).)

NITTANY COBBLER. (=IRISH COBBLER (32, 33).)

NO BLIGHT. (=PRESIDENT (1).) This is resistant to late blight (34, 37).

PAWNEE. *Origin*: U. S. D. A. (CS-1608) (25) and Colorado A. E. S. before 1940 (11). *Pedigree* (11): See pedigree combination on page 230. It is resistant to scab (22) and has a tough skin (11). It bears the name of certain scenic buttes in Colorado and also the name of an Indian tribe which once roamed an area extending from Nebraska to Texas (11).

PEACHBLOW. This is grown in the West (10).

PENNIGAN. (=WHITE RURAL (32).) (=RURAL NEW YORKER No. 2 (33).)

PERFECT PEACHBLOW. (See RED MCCLURE.) This is grown in the West (10).

PETRONIUS. This was obtained by the U. S. D. A. from Austria in 1912 (according to a letter from F. J. Stevenson). It enters into the parentage of Earlaine and Erie.

PONTIAC. *Origin*: U. S. D. A. (401-23), 1931 (24). *Pedigree* (24): See pedigree combination on page 230. It is resistant to yellow dwarf and drought (24). The name is that of a chief of the Ottawa Indians formerly a tribe of the Great Lakes region (24).

POTOMAC. *Origin*: U. S. D. A. (B247) (25) and Maryland A. E. S. (14). *Pedigree* (11, 25): See pedigree combination on page 2. It is somewhat resistant in the tubers to late blight (31) and is high in vitamin C (25). The name is that of a river in Maryland.

PRESIDENT. (=PAUL KRUGER, a Dutch variety (8).) See NO BLIGHT. It is resistant to late blight (1), immune in tubers to late blight (1), and immune to ring rot (2).

PROLIFIC. (See BROWN BEAUTY). *Origin*: In Vermont, 1861 (38). *Pedigree*: This variety and Early Rose were seedlings from the same seedball of Garnet Chili (38). Prolific is grown in the West (10).

RED MCCLURE. (=PERFECT PEACHBLOW (10).) *Origin*: In

Colorado, 1910 (38). *Pedigree*: This variety started as a sport from Improved Peachblow (38).

RED WARBA. *Origin*: In Minnesota, 1933 (18). *Pedigree*: A mutant chimera from Warba (18).

RICHTER'S JUBEL. This variety is German (34). It is resistant to scab (34). It enters into the parentage of Menominee.

RURAL NEW YORKER NO. 2. *Origin*: Before 1888 (38). It is grown in the West (10), in the South (21), and in the North (22). It enters into the parentage (see pedigree combination on page 230) of Chippewa and Katahdin, Sebago, Menominee, Houma, Mohawk and Sequoia, Pawnee and Potomac, Pontiac, and Golden.

RUSSET BURBANK. (See NETTED GEM.) (=CALIFORNIA RUSSET (38, 39).) *Origin*: Sport of Burbank, 1908 (39). It is grown in the West (10).

RUSSET RURAL. (=RURAL RUSSET=LATE PETOSKEY (38).) *Origin*: 1908 (38). It is grown in the South (21) and in the North (22). It enters into the parentage of Mesaba.

SEBAGO. *Origin*: U. S. D. A. (44488) before 1932 (35). *Pedigree* (35): See pedigree combination on page 230. It is resistant to late blight (1, 22, 32, 33, 34), mild mosaic (22, 32, 34, 35), yellow dwarf (22, 31), net necrosis (31, 36), and brown rot in Florida (31).

SEQUOIA. *Origin*: North Carolina A. E. S. and U. S. D. A. 1931 (12). *Pedigree* (12): See pedigree combination on page 230. The vines are resistant to late blight, flea beetles, and leafhoppers (12, 22, 32). The name is that of a Cherokee Indian chief born in what is now North Carolina (12).

SPAULDING ROSE (=SPAULDING NO. 4=ROSE NO. 4 (38).) *Origin*: 1904 (39). It is grown in the South (21) and in the North (22).

TRIUMPH. *Origin*: Connecticut, 1878 (38, 39). *Pedigree* (38): See pedigree combination from Garnet Chili above. It is grown in the West (10), in the South (21), and in the North (22). It enters into the parentage of Earlaine, Erie, Kasota, Pontiac, and Warba.

WARBA. *Origin*: In Minnesota before 1933 (19). *Pedigree* (19): See pedigree combination from Garnet Chili above. It is resistant to mild mosaic (19, 22) and to yellow dwarf (22).

WHITE ROSE. (=AMERICAN GIANT (10, 14). However, Lombard *et al.* state (23) that we cannot be sure that the original White Rose is the modern White Rose or the modern American Giant, or

that the original American Giant is the modern American Giant or the modern White Rose. It is grown in the West (10) and in the South (21).

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DDT AND OTHER NEW MATERIALS FOR SPRAYING POTATOES

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Copper sulfate applied to potatoes in the form of bordeaux mixture is used extensively for the control of the potato leafhopper, the potato flea beetle, early blight, and late blight. However, entomologists and plant pathologists are striving constantly to provide insecticides and fungicides that are more effective against potato pests and which can be less frequently applied than the older pesticides. The purpose of this paper is to present data concerning the effectiveness of DDT (dichlorodiphenyl-trichloroethane), Methasan (zinc-dimethyl-dithiocarbamate),

Dithane (disodium-ethylene-bisdithiocarbamate), Fermate (ferric-dimethyl-dithiocarbamate), COC-S (copper oxychloride-sulfate), CAC (Copper A Compound), bordeaux mixture, and various combinations of these materials, in insect and disease control on Irish Cobbler potatoes.

The experiments herein reported were conducted in three widely separated potato-growing areas of the state; namely, at McGuffey on muck soil, at Wooster on Wooster silt loam, and at Marietta on sandy soil near the Muskingum River. The potato leafhopper and the potato flea beetle were the primary factors in reducing yields; leaf blights were of secondary importance in 1944.

The materials were applied with specially designed power-operated self-propelled equipment that made it possible to apply a definite quantity of the pesticide to each plot. In these experiments the sprayer was calibrated to apply 200 gallons of spray material per acre; the duster, to deliver at the rate of 40, 60, and 80 pounds of dust per acre.

Data were obtained on leafhopper populations, adult flea beetle populations, amount of adult flea beetle feeding, the degree of foliage protection (as determined by estimating the percentage of dead foliage for each plot on a given date), and yields. Although more than 50 different spray and dust formulas were tested in these experiments, only those that produced results of particular interest are discussed in this paper.

Whenever direct comparisons were to be made between copper compounds, the formulas were prepared so that the copper content (expressed as metallic equivalent) was approximately equal. Four pounds of 25 per cent water dispersible DDT composition furnished by the DuPont Corporation was used in 100 gallons of water or spray mixture (equivalent to 1 pound of DDT).

Presentation of Data

Table 1 summarizes the data obtained from 12 different spray and dust formulas tested at McGuffey. COC-S gave results comparable to those obtained with bordeaux mixture. The addition of calcium arsenate to the bordeaux and COC-S formulas did not result in significantly larger yields than were secured when these materials were used alone. Methasan used in combination with calcium arsenate gave good control of the potato leafhopper, excellent yields, and the vines remained green longer than those that received bordeaux mixture. In 1943, Dithane gave the highest yield in a test comparing 26 different formulas; in 1944 this material was less effective than bordeaux mixture.

TABLE 1.—*Foliage condition, number of adult flea beetle feeding punctures, leafhopper populations, and yield for the treatments shown,* McGuffey, 1944 (1)

Treatment	Per cent Foliage Alive Aug. 22	Flea Beetle Feeding Punctures 10 Leaves	Leafhopper Nymphs per 100 Leaves	Bushels per Acre (2)
Bordeaux, 8-8-100	22	90	442	477
Bordeaux, 8-8-100; Calcium Arsenate, 4 lbs.	19	51	348	488
COC-S, 4-100	6	147	124	480
COC-S, 4-100; Calcium Arsenate, 4 lbs.	7			
Methasan, 2-100; Calcium Arsenate, 4 lbs.	38	76 61	150 26	464 546
Fermate, 2-100	3	155	1234	317
Dithane, 2-100	0	160	286	438
DDT, 1-100	15	47	0	571
Fermate—DDT, 2-1-100	38	39	0	599
COC-S—DDT, 4-1-100	35	36	0	570
Bordeaux—DDT, 8-8-1-100	70	42	0	589
COC-S—Calicum Arsenate—Talc, 15-10-75, 40 lb./acre	1	105	238	390
COC-S—Calicum Arsenate—Talc, 15-10-75, 60 lb./acre	4	95	86	440
COC-S—Calicum Arsenate—Talc, 15-10-75, 80 lb./acre	7	128	104	493
Fermate—Talc, 10-90, 60 lb./acre	9	111	160	461
Untreated	0	208	1544	316

(1) Figures are the means of five replications.
(2) A difference of 52 between mean values is required for significance at the 5 per cent level.

Fermate used as a spray gave poor leafhopper control and low yields. Plots treated with a Fermate—talc dust mixture gave significantly better results than were obtained from those that received Fermate as a spray. A dust mixture of COC-S, calcium arsenate, and talc gave increased yields when the amount of dust applied per acre was stepped-up from 40 to either 60 or to 80 pounds per acre; the latter rate of appli-

cation gave results comparable to those obtained with bordeaux mixture. All the various formulas that contained DDT gave phenomenal leafhopper control, a significant reduction in the number of adult flea beetle feeding punctures, and significantly higher yields than those secured with any other treatment except Methasan. Plants sprayed with DDT produced vigorous vines with large leaves and leaflets that were less distorted than is generally considered normal for Ohio-grown potatoes.

Table 2 presents data on the degree of foliage protection, leafhopper populations, reduction in the number of adult flea beetle feeding punctures, and yields obtained from seven different treatments in a series of tests conducted at Wooster. Calcium arsenate in combination with bordeaux mixture reduced the degree of flea beetle damage without affecting the yield. The addition of calcium arsenate to the COC-S formula increased the yield significantly. Methasan gave fair leafhopper control and a yield comparable to that obtained with bordeaux mixture.

TABLE 2.—*Foliage condition, number of adult flea beetle feeding punctures, leafhopper populations, and yield for the treatments shown, Wooster,* 1944 (1)

Treatment	Per cent Foliage Alive July 17	Flea Beetle Feeding Punctures 10-15 mm. Leaf Discs	Leafhopper Nymphs per 100 Leaves	Bushels per Acre (2)
Bordeaux, 8-8-100	64	616	41	112
Bordeaux, 8-8-100; Calcium Arsenate, 4 lbs.	67	364	27	113
COC-S, 4-100	54	1136	122	101
COC-S, 4-100; Calcium Arsenate, 4 lbs.	59	729	39	113
Dithane, 2-100	46	1259	162	92
Methasan, 2-100; Calcium Arsenate, 4 lbs.	62	852	390	116
COC-S—DDT, 4-1-100	71	391	0	126
Untreated	21	1720	1388	75

(1) Figures are the means of five replications.
(2) A difference of 11 between mean values is required for significance at the 5 per cent level.

DDT used in combination with COC-S gave good foliage protection, excellent leafhopper control, and a significant increase in yield over that obtained with any other treatment.

Table 3 gives data obtained in another series of experiments at Wooster comparing bordeaux and CAC formulas when used alone and in combination with calcium arsenate and DDT. The use of calcium arsenate with both the bordeaux and CAC formulas resulted in a reduction in the number of adult flea beetle feeding punctures and an increase in yield. DDT gave good flea beetle control, excellent leafhopper control, and significantly higher yields than those secured with any other treatment.

TABLE 3.—*Number adult flea beetle feeding punctures, flea beetle populations, leafhopper populations, and yield for the treatments shown, Wooster,* 1944 (1)

Treatment	Flea Beetle Holes in 15 mm. Leaf Disc	Number of Adult Flea Beetles Caught in 10 Net Sweeps	Leafhopper Nymphs per 100 Leaves	Bushels per Acre (2)
Bordeaux, 8-12-100	8	112	30	164
Bordeaux, 8-12-100 Calcium Arsenate, 4 lbs.	4	34	8	179
CAC, 4-100	12	102	82	156
CAC, 4-100	9	42	50	179
Calcium Arsenate, 4 lbs. Dithane, 2-100	17	332	96	144
DDT, 1-100	4	38	0	225
CAC—DDT, 4-1-100	1	19	12	229
Fermate—DDT, 2-1-100	3	42	0	240
Untreated	14	121	172	112

(1) Figures are the means of five replications.

(2) A difference of 42 between mean values is required for significance at the 5 per cent level.

Table 4 shows the yields obtained from plots that received 10 different spray formulas in a third series of tests conducted at Wooster. This planting was made very late in the season and plant pests did not cause much damage to the vines. In each instance, plots sprayed with formulas that contained DDT gave large, but not always significant, increases in yield.

TABLE 4.—*Yields for the treatments shown, Wooster,* 1944 (1)

Treatment	Bushels per Acre (2)
Bordeaux, 8-12-100	278
CAC, 4-100	278
CAC—Calcium Arsenate, 4-4-100	274
Fermate, 2-100	263
Fermate—Calcium Arsenate, 2-4-100	278
CAC—DDT, 4-1-100	331
Fermate—DDT, 2-1-100	321
Bordeaux—DDT, 8-12-1-100	318
DDT, 1-100	336
DDT, 1/2-100	335

(1) Figures are the means of four replications.
(2) A difference of 60 between mean values is required for significance at the 5 per cent level.

Table 5 summarizes the data on the reduction of leafhopper populations, the degree of foliage protection, the decrease in the number of adult flea beetle feeding punctures, the reduction in adult flea beetle populations, and the yields obtained from eight treatments in a series of tests at Marietta. The addition of calcium arsenate to bordeaux mixture reduced the degree of flea beetle injury without affecting the yield. However, when calcium arsenate was added to the CAC formula, a considerable increase in yield resulted. DDT, used alone or in combination with CAC and Fermate, gave an outstanding reduction of the potato leafhopper populations, exceptional control of the potato flea beetle, and significantly higher yields than those that received any other treatment.

Table 6 presents data taken at Marietta which show that DDT has a much greater residual efficiency in reducing flea beetle populations than the other pesticides used in that experiment. Six, as well as 4 days after treatment the flea beetle populations on DDT-sprayed plots were only 10 per cent as large as those of the untreated plots, and after an 8-day period only 50 per cent as many insects were present. Flea beetle populations on plots receiving other pesticides were from 50 to

TABLE 5.—*Foliage condition, number adult flea beetle feeding punctures, flea beetle populations, leafhopper populations, and yield for the treatments shown, Marietta, 1944 (1)*

Treatment	Per cent Foliage Alive July 25	Flea Beetle Holes in 15 Mm. Leaf Disc	Number Adult Flea Beetles Caught in 10 Net Sweeps	Leaf-hopper Nymphs per 100 Leaves	Bushels per Acre (2)
Bordeaux, 8-12-100	25	185	78	800	298
Bordeaux, 8-12-100; Calcium Arsenate, 4 lbs.	30	145	53	200	301
CAC, 4-100;	10	194	121	1800	241
CAC, 4-100 Calcium Arsenate, 4 lbs.	25	187	59	500	296
Dithane, 2-100	22	212	99	800	264
DDT, 1-100	35	48	37	100	356
Fermate—DDT, 2-1-100	50	76	26	•	441
CAC—DDT, 4-1-100	50	61	26	0	413
Untreated	0	271	157	2400	218

(1) Figures are the means of five replications.
(2) A difference of 68 between mean values is required for significance at the 5 per cent level.

100 per cent of those of the untreated plots on the second day after application of the spray material.

SUMMARY

DDT in 1944 gave the most outstanding performance of any material that has been recorded for use on potatoes during the past 25 years. This insecticide, used alone and in combination with various fungicides, gave remarkable control of the potato leafhopper, exceptional flea beetle control, and significantly higher yields (at the one per cent level) than those secured with any other treatment as shown in tables 1, 2, 3, 4, 5, and 6. The influence of DDT on leaf character and vine vigor was outstanding. Furthermore, it seems very probable that the use of DDT will bring about important changes in our potato spray formulas and spray practices, the extent of which cannot be predicted at this time.

TABLE 6.—*Adult flea beetle populations at 2-, 4-, 6-, and 8-day periods after spraying for the treatments shown, Marietta,* 1944

Treatment	Days after Spraying			
	2	4	6	8
Fermate—DDT, 2-1-100	1	8	6	52
CAC—DDT, 2-1-100	3	7	8	58
DDT, 1-100	4	8	11	48
Bordeaux, 8-12-100	25	87	76	86
Bordeaux—Calcium Arsenate, 8-12-4-100	21	50	60	112
CAC—Calcium Arsenate, 4-4-100	19	49	66	110
Copper—Lime Dust, 20-80	41	65	116	99
Copper—Lime—Calcium Arsenate Dust, 20-70-10	26	74	73	106
Untreated	90	141	127	90

In the meantime, more information on dosage, residual efficiency, spray intervals, etc., must be obtained before this insecticide can be used most effectively and efficiently.

Methasan gave results comparable to those obtained with bordeaux mixture. The vines remained green longer than those receiving any other treatment, with the exception of DDT, and the yields were significantly better than those obtained with bordeaux mixture in one experiment as you will note in tables 1 & 2.

In the 1943 tests, Dithane gave the highest yield in a test comparing 26 different formulas. The poor performance of this material in 1944 may be attributed, in part at least, to an inferior formulation (low per cent active ingredient) provided by the manufacturer.

Fermate used as a spray gave poor leafhopper control and low yields. Significantly better results were obtained with this material when it was applied as a dust as shown in table 1. In a series of tests conducted in 1942 comparing 23 different formulas, a 10-90 Fermate talc dust mixture, gave the highest yield, and the vines remained green longer than did those that received any other treatment.

The addition of calcium arsenate to bordeaux, COC-S, and CAC

sprays applied to muck-grown potatoes did not result in significantly larger yields than those obtained when these materials were used alone. However, the application of the several fungicides in combination with calcium arsenate to upland-grown potatoes usually resulted in some increase in yield as you will observe in tables 1, 2, 3, 4, 5, and 6. DDT, used in combination with various fungicides, gave a 57 per cent larger reduction in the number of adult flea beetle feeding punctures than was obtained with calcium arsenate.

A dust mixture of COC-S—calcium arsenate—talc carefully applied under optimum conditions and in sufficient quantity (80 pounds per acre) to cover all of the foliage completely gave results comparable to those secured by spraying with bordeaux mixture (see table 1).

During the past few years considerable work has been done with the fixed copper compounds. Of these, the chlorides are the most effective in controlling potato pests but in Ohio the results are not quite as good as are the results obtained from the use of bordeaux mixture, as shown in tables 1, 2, 3, 4, and 5.

LEAK, CAUSED BY *PYTHIUM DEBARYANUM* HESSE, PRODUCES TYPICAL "SHELL ROT" OF POTATO IN IDAHO

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and
W. W. RAY[2]
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Surveys of potato storages in Idaho in 1943-'44 and 1944-'45 conducted by the Emergency Plant Disease Prevention, U. S. Department of Agriculture, indicated that one particular type of tuber rot occurred in storages over a wide area and in some cases accounted for severe loss. On the 1944 crop, this rot was of much greater importance than in 1943. The most characteristic symptom of this rot is the breaking down of the inner tissues into a brown, soft decay, leaving in most cases a shell of healthy tissues often a quarter of an inch thick almost completely surrounding the affected area (Fig. 1, A-D). This condition gave good reason for the application, almost without exception, of the term "shell

[1]Plant Pathologist.
[2]Mycologist.

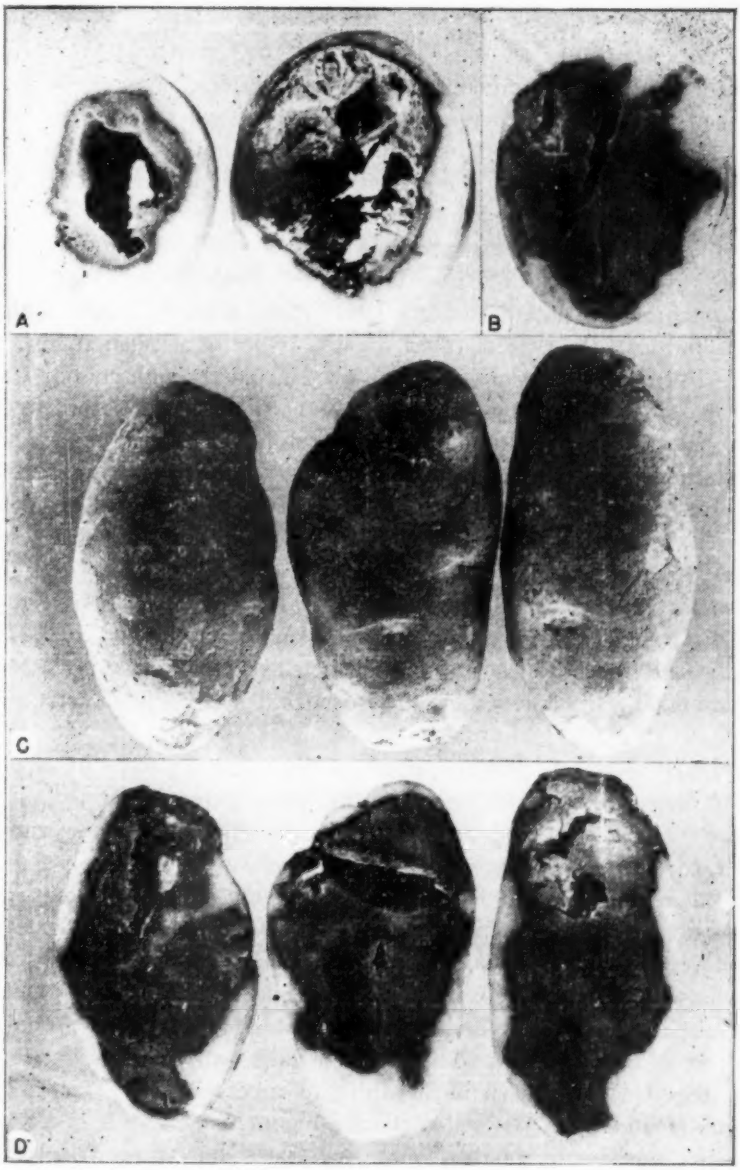

FIG. 1. Potato leak showing typical "shell rot" symptoms. A. Late stage in which tissue is drying up forming a hollow shell. B. Cross section of diseased tuber. C. "shell rot" tubers showing slight bruises where disease started. D. Same tubers shown in C but cut lengthwise to show extent of rot and prominent margin.

rot." In 1943, the disease was thought, from observation alone, to be black leg.[3]

The occurrence of "shell rot" in the 1944 crop was prevalent and caused great concern among growers and dealers. Numerous samples of shell rot-affected tubers were collected in several localities in the state during the fall, and tissue isolations from these samples consistently yielded *Pythium debaryanum* Hesse. Symptoms of the disease on tubers a few days to a month or so after digging in the fall varied, but these symptoms were predominantly a leak involving finally the whole tuber and resulting in a very watery breakdown (Fig. 1, B,D). Examinations in potato storages later in the season showed that after the initial loss, the type of tuber rot was typically a "shell rot" (Fig. 1, A,D.). Infection was observed to have started through cuts or wounds and in some cases through the stem end. The rotted tissue was typically brown in color, although the shade differed among tubers and was of a uniform texture such as a soft paste. At higher temperatures in early storage water dripped from infected tubers in great quantities, but later the tissues rotted and dried up forming cavities with little loss free water (Fig. 1,A). The margins of the rotted tissues were typically sharp cut and a darker brown than the rest (Fig. 1,D).

In 1944, leak was especially prevalent in the lower Snake River Valley and in south central Idaho such as around Gooding, Jerome, Buhl, and Twin Falls. Very little occurred in the upper Snake River Valley.

From observations, the amount of leak that develops in a particular lot depends mostly on high temperatures during and immediately following harvest. Since there was little evidence that the rot spread from tuber to tuber in storage, infection seemed to originate in the field. Careful digging and handling also influence the amount of bruising and subsequent rot. The influence of leak on stock for seed and measures for its control are also important. A brief description and discussion of what apparently is this same disease under the term "watery wound Rot" as it occurs in England is of interest.[4] Similarity of the symptoms to those of black leg rot, the relation of high temperatures during harvest, together with mechanical injury to tubers, and the fact that the fungus (*Pythium* sp.) is soil-borne are mentioned.

The purpose of this brief note is to point out two particular facts.

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[3]Blodgett, Earle C. Potato diseases in Idaho in 1943. Pl. Dis. Rptr. 29:51-57. 1945.

[4]Anon. Pink rot and watery wound rot of potatoes. Advisory Leaflet No. 292. Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.I., 1938, Revised, 1945.

1. Leak has been known for a long tme as a disease in early potato crops in Idaho but it has not previously been regarded as a disease in stored potatoes. 2. Leak has not previously been regarded as being in the "shell rot" complex although it is now considered that leak is the principal cause of typical "shell rot" as known by potato men generally in the state. It probably has been present in varying amounts as long as potatoes have been grown here.

This information can be of value in extension work since "shell rot" has also been used, but with much less accuracy, in connection with black rot and dry rot (*Fusarium spp*), ring rot (*Corynebacterium sepedonicum*) and in black leg (*Erwinia phytophthora*).

SECTIONAL NOTES

INDIANA

The potato situation in our state is rather quiet at this time. This is perhaps because a lot of locally-grown potatoes are finding their way to the market and we have not had to depend so much on shipped-in potatoes. For a while, the situation was rather dark and some few of our buyers thought that we were threatened with a potato famine. The early commercial crop has been harvested as well as a lot of potatoes from the home gardens, which has been a very important factor in the potato situation this year in our state, whereas the late potatoes are in a good state of growth, look very healthy, and have the promise of good yields. All potato growers, as well as gardeners, have been troubled with the leafhopper and more sprays and dusts have been applied this year than ever before. I am happy to report that our growers have been doing a good job in controlling the potato pests and we also found a little late blight on the early potatoes,—the first time in a long period that the blight has shown up in Indiana. The early harvest of the late-maturing crop will start during the last of August to the first of September and we anticipate having the bulk of the potatoes harvested and in storage or disposed of by the first of October. (July 27).—W. B. Ward.

KENTUCKY

The early season has been kind to our potato growers, and good yields of high quality were harvested. Digging will be completed about two weeks earlier than usual, as the demand has justified getting the crop out of the ground promptly.

Second-crop prospects are good. The acreage is the same as last year. 1,800.

The interest in the Sequoia variety is increasing. It has outyielded Irish Cobbler in the past three crops, and consumer demand is also increasing. However, we find the Sebago quite too long-seasoned. Starting early enough to mature a good crop in the fall, it encounters weather quite too hot and dry, which handicap it does not appear to be able to overcome. It is quite unsuitable here for early planting, as it might mature in July or August,—when the weather is normally hot and dry.—(July 30) —JOHN S. GARDNER.

LONG ISLAND

The Long Island potato crop is now about mature. A portion of the early crop on the lighter lands was severely injured by the very hot weather in June. Other than that the crop as a whole, both early and late, is very good. The quality of the potatoes is excellent and the yield is much better than average.

Up to this date, the 13th of August, it is believed that more than one-half of the early crop, which is at least 50 per cent of the total has been marketed. In some important areas where the early crop predominates, like Orient and Southold, the crop is probably three-quarters marketed. In some cases growers have finished marketing their early crop and are now working on the Green Mountains.

There has been almost no loss from sun scald or late blight infection on the tubers. Several years ago these troubles were the cause of serious losses. (Aug. 13).—H. R. TALMAGE.

MARYLAND

Nearly all the Worcester County potato crop has been harvested. Yields of 100 barrels per acre were common in many healthy fields. Much Leaf Roll was present in many of the fields from northern grown seed and in these fields yields were reduced from 10 to 50 per cent. The losses from tuber rot were severe in many fields that were harvested late in July.

In Garrett County Late Blight has been found in all fields which were visited. Many of the unsprayed fields are so severely diseased that all the vines will be dead within the next few weeks if weather conditions continue to be favorable for blight development. (August 6)— R. A. JEHLE.

NEBRASKA

The late potato crop in western Nebraska, which was planted considerably later than usual, has about reached normal growth for this time of year. There has been favorable weather, that is, cool, with

plenty of moisture throughout the area. In general, the stands are good on both dry land and irrigated, with an occasional field showing poor stands because of seed breakdown at the time of planting.

Insect pests are less than usual throughout most of the territory. In occasional fields, blister beetles and grasshoppers are doing considerable damage, but spraying or dusting for their control is being practiced. Flea beetles, which have been a plague in many sections of the western Nebraska potato areas, have been found in smaller quantities than usual. The entomologists in the University of Nebraska, in cooperation with entomologists of the United States Bureau of Entomology have been making surveys. The information from the surveys is submitted to growers. This service proved very popular, and of considerable value to potato growers throughout the territory. They report on all potato insects, giving the population, where, whether increasing or decreasing, and give recommendations for control. In addition to the insects already mentioned above, psyllids are found in serious percentages only in the very early planted stock, where treatment is necessary. The late main crop is affected but slightly, and no control is advisable at this time.

Many growers are watching with interest the tests being made with the new insecticide, DDT. It is being applied on field scale for the first time. The experimental plats conducted a year ago indicated its superiority to most of the known insecticides, particularly with control of psyllid, flea beetle and leafhoppers. This year it is being applied as a spray and a dust, with ground machines, and also by airplane. The airplane tests were solely experimentation, but first reports are quite satisfactory.

The first field inspection of Certified and War Approved fields was begun about the 20th of July, and is practically completed at this writing. No unusual diseases nor conditions have been found, which would cause an undue amount of rejections.

The early potato crop in central Nebraska is better than half harvested and some difficulties have been experienced with field rots and rotting in shipment. In general, however, the quality of the crop has been excellent. (Aug. 9)—MARX KOEHNKE.

NEW YORK

Planting operations were retarded because of continuous rains and this has resulted in a great many late-planted pieces of potatoes and in poor stands, due in some cases, to drowning out; in many cases to rotting of seed pieces after planting; and in many instances to seed decay which started before planting. The trouble resulting from the decaying of both seed and table stock caused by Fusaria, and, in most cases apparently due to *Fusarium sambucinum* F. 6 was much greater than resulted. Black

leg is somewhat more prevalent than usual and is apparently more common in the Sebago variety. Leafroll percentages are running a little bit higher than the Florida results led us to expect, but not so high as in many other years. Some localities which have been free from leafroll for many years are now showing considerable amounts. The weather since planting time has been favorable for late blight development most of the time. The disease has been reported on reliable authority from many localities. I have observed it myself in three fields,—the first one on July 11th. Infections were already abundant in the field at that time. Notwithstanding the unfavorable factors mentioned, potatoes have been making a good growth with favorable weather conditions and I would say the prospects at present are for an average crop. (July 28)—KARL H. FERNOW.

NEW YORK

Most of the important potato counties have been favored with good growing weather since our report of a month ago. Our July rainfall was nearly normal or above in upstate counties, whereas Long Island was a little short in parts of Suffolk County. Since the 1st of August, blight has taken many of the poorly sprayed fields on the Island and right now is injuring the crop on muck. The worst pest at this time is hopper injury. Even in fields well sprayed with Bordeaux mixture, it has been impossible to control leafhopper except where DDT or some form of pyrethrum has been used.

Long Island is assured of a better than average yield from the largest acreage ever planted there. Anything can happen to the crop upstate. Many fields are uneven because of rotted seed and the poor sprout conditions since planting time. Sebagos are especially bad whereas Katahdins are generally better. An unfavorable storage season last winter and spring has again demonstrated the poor keeping quality of Sebago and the excellent keeping quality of Katahdin, Green Mountain and Rural.

This year, the poor sprout condition of the seed tubers has resulted in an abnormally large number of stems per plant and a correspondingly large set of tubers. This means that anything which seriously checks growth from now on, whether it be leafhoppers, blight, or drought, is likely to result in a crop which will grade a high percentage of No. 2 size potatoes. In this situation, the Katahdin, Chippewa, Pontiac, Sequoia, and Sebago varieties are most likely to develop the best yield.

Hoppers or blight or both have already killed potato plants in many gardens and in most poorly sprayed fields. Digging is well along in Nassau County where excellent yields are reported. Shortage of labor for harvest and shortage of heavy trucks for hauling are causing growers

in Steuben and some other Western New York counties considerable concern. (Aug. 13)—E. V. HARDENBURG.

NORTH CAROLINA

The 1945 early Irish potato season in North Carolina was one of the most unusual, as well as successful, in the history of potato growing in this area. The quality of potatoes was good, and the growing and shipping conditions almost ideal. The Federal State Market News Service reports that the size proved very satisfactory with probably 85 per cent or more grading size A. Both the size and condition of the potatoes were so favorable, that some growers sold considerable quantities direct from the field, either as field graded or field run. Most of these potatoes moved by truck from the Mount Olive section where it was estimated that approximately 90 per cent of the crop was handled by this method of transportation. The acreage in this area was small to begin with and much smaller in 1945 than in 1944.

As previously reported the 1945 acreage was somewhat reduced but this occurred largely with small growers,—many of whom planted potatoes last year on land which was unsuitable. The dropping out of a large number of small growers, and others who were speculating in 1944, helped to raise the average yield which was substantially above the 10-year average and more than 50 per cent above 1944, as reported by the Federal State Market Service.

The market started at ceiling prices and remained there throughout the season,—the ceiling for 100 pound sacks, until the 1st of June of U. S. No. 1, size A, being set at $3.10. On this date the ceiling dropped from 20 cents to a ceiling of $2.90 for U. S. No. 1, size A. An additional mark-up of 14 cents per bag was allowed for sales on a delivered basis when the shipper took the transportation risk. Various government agencies purchased a considerable quantity of North Carolina potatoes at 8 cents above f.o.b. ceiling.

Including the 22nd of June, 5735 cars had moved from North Carolina, whereas in 1944, the total was 4568 cars. Digging is completed in most areas, but may continue north of Albemarle Sound through June.

We are hoping that the unusual year just completed will not result in over-planting in 1946. (Aug. 6)—M. E. GARDNER.

OHIO

Harvesting of our early crop of potatoes is underway but the movement of potatoes has been very limited during the last couple of weeks. Our dealers ordered heavily when potatoes became more abundant and the Ohio markets are now loaded with out-of-state potatoes from New York,

California and intermediate points. The Ohio growers are withholding harvesting until some of the out-of-state stocks are moved into consumer channels.

The Cobblers set heavy and the tubers are of medium size. The price is being held around ceiling, with very light movement.

There has been considerable aphis damage in Ohio. In fact, we have seen more aphis than ever before. In some sections,—especially in the Coshocton area, aphids have killed the early crop prematurely.

Rains in most sections have been ample with the possible exception of northeastern Ohio. The late crop looks very promising. Our total yields will be above those of last season when we had a serious drought. (Aug. 14)—EARL B. TUSSING.

OREGON

The May rains totalled 4.75 inches, as compared with a normal rainfall of 0.90. Inasmuch as May is the heavy potato planting month, this seriously affected a considerable acreage of land and greatly delayed practically the entire crop. Some intended acreage was not planted, because diseases and decayed cotton pieces have reduced stands.

A survey made by the Klamath Potato Growers' Association, covering 123 growers, showed an average loss at this time of 21.4 per cent. It is felt that this condition cannot be made up throughout the remainder of the growing year and that the average yield will be only about 75 per cent or 80 per cent of normal.

Potato certification reached an all-time high, with 2,500 acres included. The first field inspection is now under way and shows a fairly heavy rejection, undoubtedly due, to some extent, to unfavorable weather conditions. The acreage, commercial as well as certified seed, seems to be somewhat higher than last year,—estimated from 5 to 10 per cent. (July 30).—C. A. HENDERSON.

PENNSYLVANIA

Late blight on potatoes has become rather general in distribution throughout the state, and is beginning to be serious in Southeastern counties where rainfall has been excessive during the latter half of July. Here it is reaching epidemic proportions.

In the northern counties, late blight is present throughout practically every county but is progressing more slowly than in southern counties.

The crop, in general, is rather poor as a result of cool, wet weather during the planting period that caused poor stand. Poor stands are more noticeable on the Sebago variety than on Russets and Katahdin. (July 30).—O. D. BURKE.

SOUTH DAKOTA

The acreage of potatoes entered for certification in 1945 is approximately 8,700, which is a large increase compared with the acreage entered in 1944. Rejections have been about average and the final acreage eligible for certification will be about 8,000. As usual Bliss Triumphs comprise the largest acreage, followed by Irish Cobbler and Pontiacs. Only 40 acres of Early Ohios were entered for certification this season and most of these were rejected. The Early Ohio is a variety of the past so far as certification is concerned.

Rains have come at opportune times and the crop in most areas will be exceptionally good. Samples taken from fields indicate that the yield will range between 100-250 bushels per acre. Harvesting of the early Bliss Triumphs will start about the 27th of August. Several growers use defoliant to kill the vines in order to harvest early.

Very few storage houses have been constructed this season because of the lack of material and the shortage of labor. This means that most of the new growers will have to put their stock on the market this fall. Mexican National labor has been imported to help with the potato harvest.

All factors combined point to another good year for the certified potato growers. (Aug. 11).—JOHN NOONAN.

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THE POTOMAC POTATO

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In response to requests from numerous potato growers for higher-yielding potato varieties with better quality and more resistance to diseases, a cooperative potato-breeding program was inaugurated in 1932 by the University of Maryland, in cooperation with the United States Department of Agriculture.[1] Seedlings produced as a result of many different crosses have been planted and multiplied at Oakland, Maryland, where the elevation is more than 2,500 feet above sea level. Yield records for the most promising seedlings and new and old potato varieties have been obtained in various parts of the state. At Oakland, yield records were obtained in both sprayed and unsprayed fields, and the reaction of the different varieties and seedlings to various diseases and insects has been observed. As a result of these studies, seedling B247 was developed, which has qualities that will make it more

*State Plant Pathologist.
†Principal Geneticist.
[1]Begun in cooperation with Dr. J. H. Beaumont, formerly Head of Department of Horticulture, University of Maryland.

profitable to grow in Maryland than some of the older standard varieties. The name Potomac was chosen for this seedling, after the historic river which bears that name.

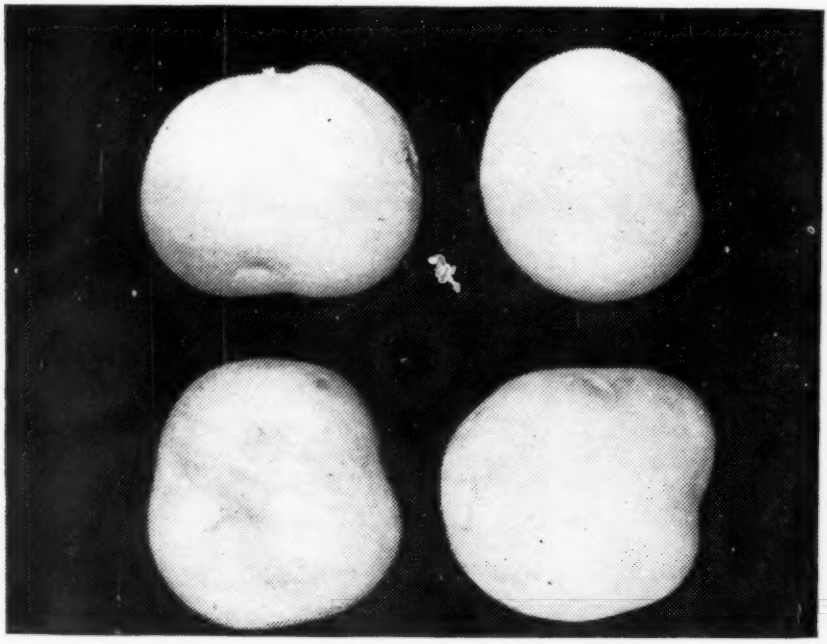

FIGURE 1. Tubers of the Potomac Potato

ORIGIN

The Potomac variety of potato (B247) originated from a cross of Rural New Yorker x Katahdin, which was made at Presque Isle, Maine, in 1930. In 1932, the seedlings were started in pots in the horticultural greenhouses of the University of Maryland, College Park, Maryland, and transplanted to the field of the Plant Industry Station, Beltsville, Maryland. Selections were made, and these were taken in 1933 to Oakland, Maryland, for increase and further tests. Potomac has been under observation and test since that time. The pedigree of Potomac is as follows:

Potomac U.S.D.A. Seedling (B247)	Katahdin	U.S.D.A. Seedling No. 24642	Sutton Flourball
			Aroostook Wonder
	Rural New Yorker	U.S.D.A. Seedling No. 40568	Busola
			Rural New Yorker

Description[2]

Plants large, spreading; stems thick, prominently angled; nodes swollen, slightly pigmented, reddish purple; internodes reddish purple; wings straight, green; stipules small, green, abundantly pubescent; leaves long, broad, open, and dark green; midrib green and scantily pubescent; primary leaflets ovate, large, 3 or 4 pairs, mean length 45.32+0.53 mm. (1.78 inches), mean width 31.34+0.40 mm. (1.23 inches), index 69.22+0.43[3] 5 petioles green; secondary leaflets many, two positions—on midrib between pairs of primary leaflets, and at junctions of midrib and primary leaflet petioles; tertiary leaflets many in number; inflorescence much branched, leafy bracts none to few; peduncles medium to long, little pigmented, scantily pubescent; pedicles short to medium, much pigmented, abundantly pubescent.

Flowers with calyx lobe tips long, green, pubescence scant; corolla medium in size, 26-28 mm. (1.02-1.10 inches) diameter, color a light lilac (corresponding to Ridgway's mauvette[4]); anthers orange to lemon yellow; pollen scant, poor quality; style straight; stigma globose, multilobed, green.

Tubers short elliptical to roundish. Mean length, 73.6+0.80 mm. (2.90 inches)[5]; mean width, 84.7+0.65 mm. (3.33 inches)[5]; mean thickness, 64.7+0.52 mm. (2.55 inches)[5]; indexes, width to length, 115.6+0.44[6]; thickness to width, 76.7+0.83[6]; thickness to length, 88.3+1.01[6]. Skin smooth, self-colored, dark cream buff. Eyes medium shallow, same color as skin. Flesh white. Maturity late.

Disease and Insect Resistance

Results of tests conducted during the past four years in sprayed and unsprayed fields at Oakland with Potomac and other potato varieties have indicated a degree of resistance to late blight (*Phytophthora infestans*) in both vines and tubers about equal to that reported for Sebago by Stevenson and Clark (2)[7]. Potomac vines have had

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[2]The authors wish to acknowledge the assistance of Robert V. Akeley, Associate Plant Breeder, Presque Isle, Maine, to whom we are indebted for the plant-character descriptions and leaf measurements. The tuber measurements and the statistical work was done by Mrs. Marguerite Toole, Junior Cytogeneticist, Beltsville, Maryland.

[3]Calculated by dividing the width by the length of each of 100 leaflets and multiplying the average of these ratios by 100. The leaflets were taken from the fourth leaf from the top of the stem, one leaflet, the distal left lateral, being taken from each leaf. Since the potato leaflet is asymmetrical the length was determined by taking the average of the measurements from the apex to the base of each respective lobe. This is a modification of the method described in Salaman, R. N. *Potato Varieties*, pp. 163-170. Cambridge, 1926.

[4]Ridgway, R. Color Standards and Color Nomenclature, 43 pp. illus. Washington, D. C., 1912.

more resistance to injury from the leafhopper, flea beetle, and tipburn complex than vines of Sebago, but not quite so much resistance to this complex as vines of Sequoia. There are indications that Potomac has some resistance to leaf roll, but further studies are necessary before its resistance to leaf roll can be accurately determined.

Cooking Quality

The cooking quality of the Potomac potato has been reported as follows by Jehle and McPheeters (1):

Potomac is a good all-purpose potato. It is a very good baking potato and is good either steamed or boiled in the skin. It is fairly good when boiled after paring and makes moderately good chips and French fries.

Adaptability

The Potomac potato is suitable for planting in all parts of Maryland. At Oakland in a 4-year average it significantly outyielded Smooth Rural, the standard variety, in an unsprayed field as well as in a field sprayed ten times with Bordeaux Mixture (table 1). At Pocomoke, Maryland, which is almost at sea level, in a 3-year test Potomac yielded more on the average than Dakota Red, the standard variety, but the difference was not significant (table 2). At elevations over 1,000 feet above sea level, Potomac can be more profitably grown than Smooth Rural and Sebago because it gives better yields.

For the grower who is not equipped to spray or dust or who cannot spray or dust thoroughly, Potomac is much safer to grow than Sequoia because Sequoia tubers are very susceptible to late blight (*Phytophthora infestans*) rot. When conditions are favorable for the development of late blight severe losses are likely to occur in Sequoia even when vines are not severely infected. In 1943, conditions were not very favorable for late blight development at Oakland, Maryland, and in the unsprayed plot the vines of Potomac and Sequoia were only slightly infected. At harvest time, late blight rot was found in only a few tubers. Fifty days later, late blight rot was found in 30 per cent of the Sequoia tubers and many of these tubers were soft and disintegrated. At the same time, late blight rot was found in only 2 per cent of the Potomac tubers and the infected tubers had shriveled and dried up.

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[5]The average of measurements of 50 tubers with a mean weight of 8.1+0.13 ounces (188-281 gm.)

[6]Calculated by dividing the width of 50 tubers by the length and multiplying the average of these ratios by 100. The data used for calculating the indexes were taken from the same measurements as those used for the dimensions of the tubers.

[7]Numbers in parentheses refer to "Literature Cited."

TABLE 1. *Average comparative yields of Potomac and other potato varieties at Oakland, Maryland, 1941 to 1944.*

Variety[1]	Yield U. S. No. 1 Tubers by per Acre Year[2]				
	1941	1942	1943	1944	Average
	Bushels	Bushels	Bushels	Bushels	
Sprayed plots					
Sequoia	335	465	565	225	398
Potomac	288	419	640	235	396
Smooth Rural	170	344	571	182	317
Sebago	201	309	409	173	273
Difference significant at 5-per cent point	43.6	58.3	83.5	35.0	58.0
Unsprayed plots					
Sequoia	167	148	228	154	175
Potomac	200	161	198	104	166
Smooth Rural	141	124	176	100	135
Sebago	145	117	141	79	121
Difference significant at 5-per cent point	23.4	29.5	23.8	27.8	26.3

[1]All seed grown at Oakland, Maryland.
[2]Average of five randomized replications.

TABLE 2. *Average comparative yields of late crop of Potomac and Dakota Red potatoes, Pocomoke, Maryland, 1941, 1943, and 1944.*

Variety[2]	Yield U. S. No. 1 Tubers per Acre[3]			
	1941	1943	1944	Average
	Bushels	Bushels	Bushels	
Potomac—Garrett County Seed	101	81	181	121
Dakota Red[4]—Worcester County Seed	41	157	96	98
Difference significant at 5-per cent point	16.2	19.3	39.1	26.9

[1]Owing to rotting of seed stock in cold storage, no yield records could be obtained in 1942.
[2]Seed kept in home storage from time of harvest to April 1, and in cold storage from April 1 to July 10.
[3]Average of five randomized replications.
[4]Worcester County seed was used because home-grown seed is always used for growing Dakota Red, since it cannot be profitably grown in Garrett County.

Potomac is preferable to Dakota Red for the late crop at elevations below 1,000 feet when the tubers can be kept in cold storage. Its shape and color make it more desirable on the market than Dakota Red and it yields just as well or better. If it is kept in home storage during the summer for planting the late crop, poor stands are likely to result unless the tubers are planted whole. Potomac should never be used for early planting at elevations below 1,000 feet above sea level south of Pennsylvania since poor quality and low yields will result from late tuberization in hot, dry soil. This was clearly demonstrated in 1944 when Potomac was included in the early test plot at Pocomoke. Samples of Potomac potatoes were sent to the University of West Virginia, in Morgantown, West Virginia, and the reports indicate that yields and resistance to disease were similar to results obtained at Oakland.

Potomac requires a long growing season, and is therefore not suitable in Maine where the season is on the average about 30 days shorter than it is in western Maryland and parts of West Virginia. Consequently Potomac is usually inferior to the commonly grown varieties in Maine. This, however, in no way lessens its value for sections to which it is adapted, such as western Maryland.

Dissemination

About 3½ acres of Potomac were certified in 1944. Most of this seed will be planted in 1945, and it should not be long before there is sufficient seed to meet the needs of growers in sections where this variety is adapted.

Summary

Potomac is a selection from a cross of Rural New Yorker x Katahdin. At Oakland, Maryland, it has yielded more than the standard Smooth Rural variety, and at Pocomoke, Maryland, as much as or more than the standard Dakota Red variety. Preliminary tests indicate that similar results may be expected in other localities with similar climatic conditions.

It is believed that Potomac will be a valuable potato variety where a high-yielding, late-maturing round white potato is desired. It possesses good baking qualities and has moderate vine and tuber resistance to late blight and to the flea beetle, leafhopper, and tipburn complex.

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SOIL MANAGEMENT FOR POTATO PRODUCTION[1]

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Soil management questions raised most frequently by potato growers have to do with the application of fertilizer, the effect of different rotations, and the use made of different crops in the rotation on the yields of potatoes. Some typical questions are: "Should the hay crop preceding potatoes be cut, fed and the manure applied for the tuber crop or is it better to plow under the hay crop as green manure for the potatoes?" "Are leguminous sods more beneficial than grass sods in potato rotations?" "Are heavy applications of commercial fertilizer to the hay crop of much value to the following potato crop?"

Experiments designed to give information which will help answer these and similar questions were carried out on the Upper Peninsula experimental farm at Chatham and on the college farm at East Lansing, and the results are presented in this paper.

COMPARISON OF THE EFFECT OF LEGUMINOUS AND TIMOTHY SODS ON THE YIELD OF POTATOES

It has been quite generally considered that alfalfa and clover are more beneficial to the following potato crop than is timothy or other grass sod for several reasons, which may be listed as follows: (a) Legumes are able to take nitrogen from the air and add it to the soil through the action of the bacteria in the root nodules; (b) The roots and stubble of legumes decay more rapidly setting free the mineral nutrients and nitrogen they contain for use by the potatoes; and (c) Legume sods are more likely to be free from wireworms. On the other hand, the fine yields of potatoes obtained by many northern Michigan growers following quack grass and timothy indicate that grass hay sods have a high value in potato rotations. Furthermore the major portion of the white skinned potatoes produced in Michigan are grown on soils that are too strongly acid for the growing of alfalfa. Liming these soils to make possible the establishment of stands of legumes usually results in greatly increased scab damage to the potatoes.

To study the relative merits of timothy, alfalfa, red clover, and alsike sods in potato growing two series of experimental plats were established on Chatham stony loam at the Upper Peninsula experimental station.

Series I consists of four sets of plats. One plat in each block was

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seeded to alfalfa, one to red clover, one to alsike, and the fourth to timothy. Seedings were made in May, 1940 and good stands were obtained. However the clovers and alfalfa winter-killed and had to be re-seeded in the spring of 1941 and as a consequence only one cutting of hay was taken from these plats before plowing for potatoes. Two crops of hay, 1941 and 1942, were cut from the timothy plat before it was plowed. After hay harvest the soil was worked until fall with a field cultivator to control quack grass and then it was plowed.

Clovers received 400 pounds per acre of a 0-14-6 fertilizer before seeding in 1940 and again before re-seeding in 1941. The timothy plat, on the other hand was given 400 pounds per acre of 10-6-4 fertilizer when seeded and again in the spring of 1941 and 1942. One half of each plat received an application of 8 tons of manure per acre before plowing.

When Russet Rural potatoes were planted in the spring of 1943, 500 pounds per acre of 4-16-8 fertilizer were applied to all the plats. The yield of hay and of potatoes are given in table I.

The yields of hay from the timothy plats were about the same as those from the alfalfa plats, but the clover plats yielded less.

Potato yields were much greater on the plats following timothy, with and without manure, than on the plats following legumes; and the yields following alsike clover were greater than the yields following red clover and alfalfa.

Manure applied to the sods the year previous increased the yields of potatoes in every case. The average increases due to the manure following alfalfa, red clover, alsike clover, and timothy were 21.7 bu., 26.9 bu., 26.4 bu. and 52.4 bu., per acre respectively.

Series II was established to study the relative effects of alfalfa and timothy, when grown in potato rotations and fertilized with varying amounts of the commercial fertilizer commonly recommended for them. Three sets of plats were arranged in Latin square design. The treatments were replicated four times. The treatments for the plats growing alfalfa were no fertilizer and 400, 800, and 1,200 pounds of 0-14-6 fertilizer per acre respectively. Timothy was grown on two sets of plats. The treatments in the first set were, no fertilizer and 400, 800, and 1,200 pounds of 10-6-4 fertilizer per acre; and in the second, no fertilizer, 200, 400, and 600 pounds of ammonium sulphate per acre.

The alfalfa and timothy were planted in the spring of 1940 but because of winter-killing it was necessary to re-seed the alfalfa in the spring of 1941. Hay was cut from the timothy plats in 1941, 1942, and 1943 and from the alfalfa plats in 1942 and 1943. The area was fall plowed and planted to Russet Rural potatoes in 1944.

TABLE 1.—*A comparison of the effect of alfalfa, red clover, alsike clover, and timothy sods on the yield of potatoes at the Upper Peninsula Experiment Station.*

All plats received 500 pounds per acre of 4-16-8 fertilizer.

The results are the average from four plots.

Hay Crops in Rotation	Average Yield of Hay Per Acre Pounds	Average Yield of Potatoes Per Acre Bu.		
		8 Tons Manure	No Manure	Increase Due to Manure
Alfalfa	7130	145.8	124.1	21.7
Red Clover	6728	156.7	129.8	26.9
Alsike Clover	6276	170.4	144.0	26.4
Timothy	7699	246.2	193.8	52.4
Increase in favor of Timothy:				
Compared to Alfalfa		100.4	69.7	
Compared to Red Clover		89.5	64.0	
Compared to Alsike		75.8	49.8	

The fertilizers were broadcast on all plats before seeding in 1940. The alfalfa plats received a second application when re-seeded in 1941, and the timothy plats received annual applications each spring. The entire area received a broadcast application of 500 pounds of 4-16-8 fertilizer just previous to planting potatoes in 1944.

The yields of hay and potatoes from these plats are shown in table 2.

The average yields of hay on alfalfa and timothy plats was about equal in both 1942 and 1943, the alfalfa plats producing an average of 5929 pounds of hay per acre and the timothy plats 5848 pounds. Applications of 400 pounds of 0-14-6 fertilizer per acre increased the alfalfa yield approximately thirty per cent, but larger applications did not give further significant increase. The yields of timothy hay were increased approximately fifty per cent by annual topdressings of 400 pounds of 10-6-4 fertilizer and of 200 pounds of ammonium sulfate per acre, and approximately 75 per cent by double these applications. Applications of 1,200 pounds of the fertilizer, however, did not give additional increases.

The yields of potatoes on the unfertilized alfalfa and timothy plats were approximately the same, averaging 272 bushels per acre on the alfalfa plats and 276 bushels per acre on the timothy plats. The alfalfa plats which were fertilized produced from 26 to 34 bushels per acre more than the unfertilized plats, the yields being 307.8, 314.6, and 316.5 bushels per acre on the plats receiving 400, 800, and 1,200 pounds of 0-14-6, respectively. Potato yields on the timothy plats that were fertilized with ammonium sulfate were almost identical to those on the fertilized alfalfa plats, the yields being 315.8, 314.4, and 300.0 bushels per acre on the plats receiving 200, 400, and 600 pounds per acre respectively. It is noteworthy, however, that the largest yields of potatoes were produced on the timothy plats that received annual applications of 10-6-4 fertilizer. The yields were 319.7, 340.2, and 381.2 bushels per acre on the plats receiving applications of 400, 800, and 1,200 pounds per acre. These increases averaged 32 bushels per acre more than did those following alfalfa.

Comparison of Different Methods of Utilizing Red Clover in a Potato Rotation on the College Farm at East Lansing

A series of twelve blocks of randomized plats, to study the effect of various methods of utilizing the red clover seeding in a corn, oats, red clover, potato rotation was established on Hillsdale sandy loam soil on the college farm at East Lansing in 1939. The treatments were as follows: (1) The first crop of red clover was cut for hay and six tons

TABLE 2.—*Yields of alfalfa and timothy hay as affected by different rates of fertilization and the comparative effect of the crop and fertilizer treatments on potato yields.*

All plats received an application of 500 pounds per acre of 4-16-8 for potatoes. Results are the average from four plats.

Hay Crop in the Rotation	Fertilizer Treatment	Average Yield of Hay Per Acre-Pounds			Average Yield of Potatoes per Acre—1944 Bushels
		1942	1943	Average	
Alfalfa	None	4528	4890	4709	272.0
	400 lbs. 0-14-6	6311	6077	6194	307.8
	800 lbs. 0-14-6	7098	6210	6654	314.6
	1200 lbs. 0-14-6	5777	6150	5964	316.5
Timothy	None	4326	3566	3946	276.1
	400 lbs. 10-6-4	6353	5683	6018	319.7
	800 lbs. 10-6-4	8032	6029	7031	340.2
	1200 lbs. 10-6-4	7945	5588	6767	381.2
Timothy	None	4948	3308	4128	275.9
	200 lbs. $(NH_4)_2SO_4$	6701	4813	5757	315.8
	400 lbs. $(NH_4)_2SO_4$	8626	5330	6978	314.4
	600 lbs. $(NH_4)_2SO_4$	7082	5232	6157	300.0

of manure were applied to the stubble. The following spring the plats were plowed and planted to potatoes. This rotation similates the rotation on a potato-dairy or a potato-livestock farm. (2) The clover crop was plowed down just before full bloom, the area kept fallow until late August and then seeded to rye as a green manure and cover crop. The rye was plowed down in the spring for potatoes. (3) The clover seeding was plowed down in the spring for potatoes making a three-year rotation of corn, oats, potatoes with the red clover seeded in the oats as a green manure crop. These two latter rotations are similar to those followed on many non-livestock farms.

In all cases the oats received an application of 300 pounds of 0-12-12 fertilizer per acre drilled at planting time and the potatoes 500 pounds of 3-12-12 in bands two inches to the side and on the same level as the seed pieces. This latter application was made with the fertilizer attachment on the potato planter at planting time.

The results of this experiment are shown in table 3.

The largest average yield of potatoes was produced in the rotation in which six tons of manure was spread as soon as the hay crop was removed in June; the second largest in the rotation in which the clover was plowed down in June, rye seeded in August, allowed to grow as a cover crop until spring, and then plowed down for potatoes; and the lowest potato yield in the rotation in which the new clover seeding was plowed under in the spring.

The oat yields were affected only slightly by the various treatments during the rotations. Corn yields in 1941 and 1942 were about the same in the three rotations; but in 1943 and 1944 the yields were considerably higher in the potato-livestock farming type of rotation in which manure was applied, than in the three-year rotation in which the clover seeding was plowed under in the spring. In 1944 the manure treatment also gave more corn than did the plowing under of all the clover plus a green manuring crop of rye.

Discussion

The data secured in the above experiments give us at least partial answers to some of the questions asked concerning potato rotations. In the first place, it is quite evident from the data obtained at the Upper Peninsula Experiment Station that timothy can be successfully used as a hay crop in potato rotations. The yields of timothy hay from plats that received liberal applications of a fertilizer designed for grasses (10-6-4) were equal to the yields of hay from fertilized alfalfa, red clover, and alsike clover plats; and of greater importance, the potato yields the following year were considerably larger. Evidently the sod of well

TABLE 3.—*Comparison of different methods of utilizing red clover in a potato rotation on the College Farm**

Crop Treatment	Potatoes			Corn			Oats			Clover
Year	1 Clover Cut for Hay-6 Ton Manure	2 Clover Plowed down Rye Green Manure	3 Clover Seeding Plowed down in Spring	1 Clover Cut for Hay 6-Ton Manure	2 Clover Plowed down Rye Green Manure	3 Clover Seeding Plowed down in Spring	1 Clover Cut for Hay 6-Ton Manure	2 Clover Plowed down Rye Green Manure	3 Clover Seeding Plowed down in Spring	1 Clover Cut for Hay 6-Ton Manure
1941	77.0	74.3	70.0	32.0	32.0	31.1	47.7	47.5	45.1	2654
1942	315.8	252.0	191.2	52.0	57.8	54.7	48.5	50.0	53.2	3217
1943	166.2	126.8	93.7	48.4	45.0	40.6	34.5	33.9	37.8	1943
1944	114.8	118.4	101.1	25.2	16.5	16.5	58.5	44.8	52.5	2384
Average	168.5	142.9	114.0	39.4	37.6	35.7	47.6	44.1	47.1	2550

*Yields given are the averages of three replicates each year.

fertilized timothy is beneficial in potato production. It is also probable that some portion of the largest applications of fertilizer remained in the soil and was used by the potatoes. Evidence of this effect is found in the fact that the heaviest application of the 10-6-4 fertilizer did not increase the yield of hay compared with that obtained from the medium application but did result in an increased potato yield. This was due in part no doubt to the fact that the hay lodged on these plats, leaving a thick mat of vegetable matter to be plowed under.

Large applications of 0-14-6 fertilizer, 800 and 1200 pounds per acre, did not increase the yield of alfalfa appreciably and the potato yield was increased only slightly. Red clover and alsike clover did not produce so large yields of hay as alfalfa and timothy, but the yields of potatoes following them were slightly larger than those following alfalfa. The yields following alsike clover were almost as high as those following timothy.

Potato production has been maintained at a higher average level on Hillsdale sandy loam soil on the college farm in a four year potato-livestock type of farming rotation than in either of the non-livestock type of farming rotations. This rotation, in which a hay crop is harvested and manure spread on the second growth and plowed down, produced on the average 25.6 bushels of potatoes and 2550 pounds of clover hay more to the acre than did the better of the two non-livestock type of farming rotations. Corn yields were higher in this rotation, in two years out of four, although the average for the four-year period was about the same as for the rotation in which the clover crop was plowed under.

The productivity of the soil was maintained at a comparatively high level by plowing down clover and rye since the average yield of potatoes in this rotation was 28.9 bushels per acre higher than in the three year potato-grain rotation in which the new seeding of clover was plowed down in the spring for potatoes. The seedling clover evidently had not made enough growth to affect appreciably the soil productivity. The fertilizer applications were identical in the cases of the two four-year rotations, but there was approximately thirty-five per cent more used per year in the three-year rotation as each potato crop received 500 pounds per acre and each oat crop 300 pounds per acre.

Oat yields were not appreciably affected by the different rotations, being nearly the same in every case.

Conclusions

From Experiments in the Upper Peninsula

1. Timothy, when properly fertilized with a high nitrogen fertilizer, such as a 10-6-4 analysis, produced as large yields of hay as did alfalfa, and slightly greater than red and alsike clovers.

2. Potato production was greater following timothy fertilized with 10-6-4 than following alfalfa, red clover, and alsike clover fertilized with 0-14-6.

3. Applications of 400 pounds of 10-6-4 per acre were superior to 1200 pound applications for timothy hay production and were very nearly as effective as the 800 pound treatments. There was more growth produced with the larger applications, but the hay lodged so badly that it was difficult to harvest. A heavy mat of vegetable material was left on the soil which increased the amount of organic matter plowed down for potatoes on these plots.

4. Potato yields were highest on the timothy plots which received the largest applications of 10-6-4 fertilizer.

5. Ammonium sulfate was equal to 10-6-4 fertilizer for hay production, but the yields of potatoes following the hay were lower.

FROM EXPERIMENTS AT EAST LANSING

6. Potato production was maintained at a higher level with manure spread on second growth clover than where the clover and a subsequent rye crop were plowed under as green manure. A 2550-pound crop of hay was harvested in addition to the increased yield of potatoes in the former rotation.

7. Clover seedings in grain plowed down in the following spring did not maintain potato yields at a high level.

8. Corn yields were somewhat higher in 1943 and 1944 in the four-year potato-livestock farming type of rotation.

THE INFLUENCE OF FERTILIZERS ON THE SPECIFIC GRAVITY OF POTATOES GROWN IN MINNESOTA[1]

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The specific gravity of potatoes has been given considerable attention because of its relation to starch content and cooking quality. Specific gravity depends upon the dry matter content or the amounts of starch, protein and mineral constituents present. In general, high specific gravity is associated with high starch content and high cooking quality in potatoes. Because of the subjective nature of cooking tests and the many factors influencing quality in potatoes (18)[4], some exceptions to this

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[4]Figures in parentheses refer to "Literature Cited."

general rule have been reported, so that potatoes which are relatively low in specific gravity are not always of poor quality. In Ireland, Drew and Deasy (6) found that for the potato varieties used in their experiments specific gravity did not indicate the relative table quality.

In Germany and in Ireland potatoes are grown commercially for the production of industrial alcohol, and consequently, the content of starch is of first importance. Specific gravity is used to measure the starch content of the potatoes at the time of delivery to the factories. In the United States specific gravity has been used largely as a measure of cooking quality in connection with experimental work. Workers in the eastern states (4,15,16) have found that specific gravity is a satisfactory measure of quality with a relatively close association existing between specific gravity readings and the scores of cooking tests. The following study was made to determine the effects of nitrogen, phosphate and potash fertilizers, both alone and in combination, on the specific gravity of potatoes.

Materials and Methods

For the specific gravity measurements, samples weighting approximately 30 pounds were taken in 1943 and 1944 from 27 field experiments in the Red River Valley and from 10 field experiments on the sandy soils from Isanti, Chicago and Washington Counties, near St. Paul, Minnesota. The potatoes from the Red River Valley were grown on heavy-textured soils of the Fargo and Bearden series and light-textured soils of the Ulen and Grimsted series. The basic fertilizer treatments consisted of 100 to 125 pounds of 43 per cent superphosphate (P), 100 pounds of 20 per cent ammonium sulfate (N), and 200 pounds of 60 per cent muriate of potash (K) per acre. The phosphate treatment was applied with the planter beside the rows. The nitrogen and potash treatments were applied with a Thompson broadcaster at the time of planting. Sulfate of potash and 31 per cent manure salts were compared with muriate as potash fertilizers at equivalent rates of potash. For three of the experiments in 1944 the fertilizers were applied at different rates of application. Ammonium sulfate was applied at rates of 100 and 200 pounds per acre (1N and 2N) and the superphosphate at rates of 100, 200, and 300 pounds (1P, 2P, and 3P). The potash fertilizers were applied at two rates (1K, 2K) equivalent to 200 and 400 pounds of KCl per acre. Each fertilizer rate was used alone and in all combinations with the other elements at the lowest basic rate. For the trials on the sandy soils near St. Paul the nitrogen, phosphate and potash treatments were applied broadcast at rates of 150 pounds each of ammonium sulfate, 43 per cent superphosphate, and 60 per cent muriate of potash. In 1944 a 6-12-18 fertilizer was applied beside the

hills with a special hand distributor at rates of 200 and 400 pounds per acre. Muriate of potash and manure salts were compared as constituents of the fertilizer.

In measuring specific gravity tuber samples of approximately 20 pounds each were weighed in air and in water shortly after the potatoes were harvested, specific gravity being equal to weight in air divided by weight in air minus weight in water. Samples for dry matter determinations were obtained by cutting transverse sections from near the center of 25 tubers to give a fresh weight of 250 grams. Duplicate samples from each lot were dried at about 60° C. in an oven provided with a fan and then dried to constant weight in an electric oven at 100° C. The amount of hollow heart in the potatoes was obtained on the samples used for the dry matter determination.

Standard statistical methods were used in analyzing the data.

Results and Discussion

Specific gravity

The results for the fertilizers used at the basic or lower rates in the Red River Valley are given in table 1 and a complete statistical analysis of the 1944 data is given in table 2. For both years the difference between locations was most prominent. Potatoes from the light-textured soils averaged about the same in specific gravity as those from the heavy-textured soils. With varietal effects excluded there were highly significant differences in the specific gravity of potatoes grown on different fields of the same soil type. This agrees with the work of others (18) in showing that the potato plant is quite sensitive to its climatic and nutritional environment. No two fields are identical in regard to the factors which influence plant growth. Primarily, there are variations in soil fertility levels, soil structure and aeration, cultural practices, disease problems and rainfall and drainage. In both 1943 and 1944 there was some injury to the potato crop because of excessive rainfall early in the season. In 1944 there were also heavy rains late in the season which caused injury to some of the fields. In 1944, as shown in table 2, there were significant differences between blocks for any one location or field. The blocks were quite widely separated from one another. On most of the fields it was noted that the block which was on slightly higher ground had the higher yields of potatoes and potatoes of higher specific gravity. This was due to water standing too long on the lower areas. Large areas of the Red River Valley have very little slope and, consequently, poor drainage. Depending on the season, a difference in elevation of two or three inches in a field will make a large difference in soil moisture conditions.

TABLE 1.—*Specific gravities of five varieties of potatoes grown under various fertilizer treatments at different locations in the Red River Valley in 1943 and in 1944.*

Variety	Number of Locations	Fertilizer Treatments, 1943					
		O	P	K	PK	MS	PMS
Cobbler	6	1.0848	1.0859	1.0792	1.0807	1.0792	1.0795
Pontiac	1	1.0822	1.0844	1.0799	1.0797	1.0798	1.0804
Kasota	3	1.0771	1.0805	1.0749	1.0746	1.0764	1.0753
Triumph	5	1.0760	1.0778	1.0742	1.0731	1.0707	1.0734
Warba	1	1.0712	1.0742	1.0744	1.0717	1.0710	1.0724
Grand average	16	1.0796	1.0815*	1.0766*	1.0766*	1.0756*	1.0764*

		Fertilizer Treatments, 1944							
		O	N	P	K	NP	NK	PK	NPK
Cobbler	4	1.0770	1.0784	1.0781	1.0751	1.0762	1.0742	1.0750	1.0748
Pontiac	2	1.0634	1.0636	1.0648	1.0632	1.0637	1.0618	1.0636	1.0638
Kasota	1	1.0719	1.0725	1.0707	1.0672	1.0712	1.0657	1.0700	1.0719
Triumph	3	1.0709	1.0693	1.0706	1.0679	1.0725	1.0671	1.0682	1.0681
Warba	1	1.0788	1.0795	1.0777	1.0773	1.0762	1.0740	1.0756	1.0748
Grand average	11	1.0725	1.0728	1.0729	1.0704*	1.0724	1.0692*	1.0707*	1.0707*

*Significant increase or decrease as compared with the no treatment. For the 1943 data differences between grand averages exceeding 0.0017 are significant at the 5 per cent level. For the grand averages of the 1944 data a difference of 0.0013 is required for significance.

TABLE 2. *Variances showing the influence of fertilizers on the specific gravity of potatoes from eleven different locations in the Red River Valley in* 1944.

Source of Variation	Degrees of Freedom	Variance Square†
Locations	10	45679.*
Blocks in locations	11	1370.*
N	1	571.
P	1	825.
K	1	25705.*
N x P	1	87.
N x K	1	215.
P x K	1	740.
N x Locations	10	183.
P x Locations	10	473.
K x Locations	10	572.
Error	118	477.

†For exact variances move decimal points eight places to the left.
*Significant difference.

The data in table 1 and the substantial analysis in table 2 show that nitrogen had no apparent influence on the specific gravity of the potatoes in 1944. Phosphate caused a significant average increase in specific gravity in 1943 and a small increase in 1944 when used at the basic rate of 100 to 125 pounds per acre. In both years the potash treatment caused a marked reduction in specific gravity. There were no significant interactions between potash and the other elements; that is, potash always reduced specific gravity to about the same extent, regardless of whether it was applied alone or with some other fertilizer. In 1944, however, there was some indication that potash lowered specific gravity more when combined with nitrogen. With the exception of the Warba Variety in 1943 and Pontiac in 1944, the potato varieties were uniform in showing a reduction in specific gravity when the potash fertilizer was used.

In 1944 three experiments were conducted with different rates of the fertilizers. The specific gravity data are presented in tables 3 and 4. The nitrogen fertilizers were observed to have no influence on the yield of the potatoes. The data show that the nitrogen fertilizers had no significant influence on specific gravity. This is in agreement with results obtained by Blood and Haddock (3) in New Hampshire, but is in contrast to the findings of Smith and Nash in New York (16), Metzger in Colorado (12), and Berkner and Schlimm in Germany (1), who have reported that nitrogen fertilizers tend to lower the specific

TABLE 3.—*Specific gravities of potatoes grown with different rates of fertilizers at three locations in the Red River Valley in* 1944.

Variety	Location Number	Fertilizer and Rate									
		Nitrogen			Phosphate				Potash		
		O	1N	2N	O	1P	2P	3P	O	1K	2K
Cobbler	1	1.0774†	1.0766	1.0765	1.0770	1.0770	1.0767	1.0784	1.0785	1.0755	1.0759
Triumph	2	1.0708	1.0708	1.0690	1.0700	1.0716	1.0719	1.0719	1.0724	1.0692	1.0681
Triumph	3	1.0671	1.0674	1.0677	1.0669	1.0676	1.0695	1.0695	1.0683	1,0662	1.0648
Average		1.0718	1.0716	1.0711	1.0713	1.0721	1.0727*	1.0733*	1.0731	1.0703*	1.0696*

†Each of the values given is an average of eight determinations.
*Significant increase or decrease as compared with the no treatment. For the 5 per cent level of significance a difference of 0.0013 is required for nitrogen rates, 0.0013 for phosphate rates, and 0.0011 for potash rates.

gravity or dry matter of potatoes. Kraft in Germany (11) found that nitrogen fertilizers increased the dry matter of potatoes. These variable results are probably caused by the different climatic and soil conditions under which the experiments were conducted and to different amounts of fertilizer used.

The phosphate fertilizer caused significant increases in yield up to the 200 pound or 2P rate. As indicated by the asterisks in table 3 the error test shows that only the two higher rates of phosphate caused significant increases in specific gravity. It will be noted, however, that with increasing rates of phosphate there was a linear increase in specific gravity. Consequently, it may be concluded that the 1P rate was effective in increasing average specific gravity. Generally, phosphate fertilizers have been found to increase the specific gravity or dry matter content of potatoes (3,9.12).

Both the 1K and 2K rates of potash increased the yields of potatoes but the 2K rate was not superior to the 1K rate. The potash used at the higher rate of application caused a slightly greater reduction in specific gravity than when used at the lower rate. A large amount of work has been done on the effect of potash fertilizers on potato quality, and it has nearly always been found that potash fertilizers, particularly those containing chlorides, lower the specific gravity, dry matter or starch content (1,3,5,8,10,11,12,15,16,18). Results are presented in tables 1 and 4 which show the effects of different kinds of potash fertilizers on specific gravity. Manure salts, muriate, and sulfate of potash were found to be about the same in increasing the yields of potatoes when applied so as to give equivalent amounts of potash. Manure salts supplied about twice as much chloride as muriate of potash. It will be noted that manure salts caused the greatest reduction in specific gravity. Sulfate caused no reduction in specific gravity. This agrees with the work of Smith and Nash (16) in showing that it is the chloride anion in the potash fertilizer which is responsible for lowering the specific gravity or increasing the water content of potatoes.

In the experiments on the sandy soils near St. Paul, the fertilizers did not influence the specific gravity of the potatoes significantly in 1943. The results indicated that a complete fertilizer high in potash was needed for potatoes on these soils. In 1944 a 6-12-18 fertilizer was used at two rates of application with muriate and manure salts used to supply the potash. The lower rates of fertilizer gave about the same yields as the double rates, and muriate did not prove to be superior to manure salts in increasing yields. The specific gravity data are given in table 5. The manure salts caused a greater reduction in specific

TABLE 4.—*Specific gravities of potatoes grown with different potash salts on three fields in the Red River Valley in* 1944.

Variety	Location Number	No Treatment	Potash Salt and Rate					
			Muriate		Manure Salts		Sulfate	
			1K	2K	1K	2K	1K	2K
Cobbler	1	1.0777	1.0758	1.0754	1.0749	1.0726	1.0784	1.0787
Triumph	2	1.0722	1.0700	1.0676	1.0693	1.0663	1.0707	1.0716
Triumph	3	1.0702	1.0670	1.0658	1.0654	1.0649	1.0691	1.0700
Average*		1.0734	1.0709	1.0696	1.0699	1.0679	1.0727	1.0734

*Difference required for significance between any two averages is 0.0014.

TABLE 5.—*Specific gravities of potatoes grown with various fertilizer treatments at different locations on the sandy soils in* 1944.

Variety	Location Number	Fertilizer Treatment				
		O	NPK	2NPK	NPMS	2NPMS
Chippewa	1	1.0524	1.0542	1.0517	1.0521	1.0474
"	2	1.0671	1.0640	1.0597	1.0642	1.0614
"	3	1.0688	1.0669	1.0646	1.0622	1.0623
Cobbler	4	1.0561	1.0567	1.0516	1.0508	1.0403
Early Ohio	5	1.0698	1.0657	1.0645	1.0658	1.0661
Average		1.0628	1.0615	1.0584*	1.0590*	1.0555*

*Significant increase or decrease as compared with the no treatment.
A difference of 0.0021 is required for significance at the 5 per cent level between any two averages.

gravity than muriate. By comparing the data in tables 1 and 5 it will be noted that the potatoes from the Red River Valley were higher in specific gravity than those from the sandy soils near St. Paul. There are marked differences in the environmental conditions in the two regions, the Red River Valley having, in general, a less humid climate and more fertile soils.

The results of the experiments in both the Red River Valley and the sandy area show that the amount and kind of potash will have a pronounced influence upon the specific gravity of potatoes. The use of excessive amounts of chlorides of potash either alone or in mixture should be avoided.

When hollow heart is present in appreciable amounts, it lowers the specific gravity of the potatoes. In these experiments the fertilizers were found to have no significant influence on hollow heart. Hollow heart generally occurs among the larger tubers in seasons or under conditions favorable for rapid growth. In Ireland, Drew and Deasy (7) have reported that when specific gravity is used to measure the content of starch, potato samples with appreciable hollow heart should be opened. Hollow heart did not influence the actual percentage of starch in the potato.

Estimation of Dry Matter from Specific Gravity

An expression of either the dry matter or starch content of potatoes is more easily interpreted than specific gravity readings, and consequently, depending on the purpose in mind, specific gravity readings have often been given in terms of dry matter or starch contents (2,6,7,14). Specific gravity has been used more than dry matter as a measure of starch content or quality in potatoes because of convenience and rapidity of determination. By use of either the weighing in air and water or salt solution methods for specific gravity (4), large samples of potatoes such as 20 pounds or 100 tubers may be used; whereas, in the case of a dry matter determination, a small weight such as 50 grams taken from a number of tubers has to be used. In using the specific gravity to express the quality ratings of potatoes, Blood and Haddock (3) moved the decimal place three points to the left and omitted the first two digits. For example, potatoes with a specific gravity of 1.080 would be given a quality rating of 80.

Data are presented in table 6 which show the relation between specific gravity and dry matter of potatoes grown in Minnesota in 1943 and 1944. A correlation coefficient of $r=0.8686$ between specific gravity and dry matter was found for 260 samples of potatoes from the Red River Valley. The following regression equation was calculated:

Per cent dry matter $=274.358$ (specific gravity) -275.061.

For 540 potato samples collected over a four-year period in Germany,

TABLE 6.—*Dry matter content of potatoes grown at twelve locations as determined by actual drying and as calculated from specific gravities using the regression equation obtained for Minnesota potatoes and using the regression equation of Scheele.*

Location Number	Samples	Mean Specific Gravity	Mean Dry Matter	Calculated Dry Matter	
				Equation*	Scheele's Graph†
	Number		Per cent	Per cent	Per cent
1	6	1.0874	22.75	23.28	21.7
2	6	1.0845	22.78	22.45	21.1
3	6	1.0827	21.72	21.99	20.8
4	6	1.0818	22.13	21.74	20.6
5	6	1.0779	21.52	20.67	19.8
6	6	1.0778	20.55	20.64	19.8
7	56	1.0766	20.31	20.31	19.6
8	6	1.0753	19.57	19.96	19.2
9	6	1.0750	20.18	19.87	19.1
10	6	1.0740	19.80	19.60	18.9
11	56	1.0700	18.51	18.50	18.1
12	56	1.0675	17.27	17.82	17.5

*Estimated from the regression equation:
Per cent dry matter = 274.358 (specific gravity) — 275.061.
†Taken from the regression equation of Scheele (14) as presented in a graph:
Per cent dry matter = 211.04 (specific gravity) — 207.709.

Scheele, Svensson and Rasmusson (14) found the very high correlations of +0.937 between specific gravity and dry matter and +0.947 between specific gravity and starch content. Their regression equations were as follows:

Per cent dry matter =211.04 (Specific gravity) —207.709.

Per cent starch =199.07 (specific gravity) —201.172.

From these regression equations they draw up charts from which either the dry matter or starch content may be obtained when specific gravity is known.

The data in table 6 show that the regression equation obtained for the Minnesota potatoes gives higher readings for dry matter content than the equation of the German workers (14). In table 7 both equations are used to calculate the dry matter contents from specific gravities of potatoes grown in New York (17), and then a comparison is made with dry matter contents as actually obtained. It will be observed that the relationship between specific gravity and dry matter content follows the regression equation obtained for the Minnesota potatoes much more closely than it does the equation of Scheele, Svensson, and Rasmusson (14). This difference is probably caused largely by the methods employed in obtaining the dry matter content. The dry matter contents of the Minnesota potatoes were based on a final drying temperature of 100° C. At this temperature there was no caramelization of sugars. After drying at 40° C. the German workers (14) placed their samples, weighing about 8 grams, on filter papers in Gooch crucibles and then washed them with water, alcohol, and ether under reduced pressure. After evaporation on a steam bath the filtrates, which contained sugars, were dried at 103° C. The residues, which contained starch, were dried at 120° C. for 3 hours. Potato starch retains some hygroscopic water at high temperatures such as 155° C. (13), and, consequently, the final drying temperatures used in obtaining the dry matter content of potatoes is of basic importance. Methods employed in obtaining dry matter content may not be entirely responsible for the different regression lines found for the potatoes grown in Minnesota and in Germany. It is possible that differences in varieties and in soil and climatic conditions of plant growth may have had some influence on the relationship between the specific gravity and dry matter content of the potatoes.

Summary

Specific gravity measurments were obtained for samples of potatoes from 37 fertilizer experiments in the Red River Valley of Minnesota and on sandy soils near St. Paul, Minnesota in 1943 and 1944.

The greatest differences in specific gravity were found between locations. Nitrogen fertilizer had no apparent influence on specific

TABLE 7.—*Dry matter content of potatoes as determined by actual drying and as calculated from specific gravities using regression equations.**

Test Number	Samples	Mean Specific Gravity	Mean Dry Matter	Calculated Dry Matter†	
				Equation	Scheele's Graph
	Number		Per cent	Per cent	Per cent
7	10	1.095	24.606	25.36	23.3
4	10	1.095	24.396	25.36	23.3
6	10	1.094	24.931	25.09	23.1
5	10	1.093	25.196	24.81	22.9
9	10	1.092	24.684	24.54	22.7
8	10	1.092	24.403	24.54	22.7
1	9	1.091	24.326	24.26	22.5
2	10	1.079	21.598	20.97	20.0
3	10	1.066	18.957	17.41	17.2

*Specific gravities and dry matters taken from tables 1 and 2 in paper no. 240, Department of Vegetable Crops, Cornell University, Ithaca, New York (17).
†Footnote table 6.

gravity. The phosphate fertilizer caused a small but significant increase in specific gravity, particularly when used at the higher rates of application.

The potash fertilizers containing chlorides caused a marked reduction in specific gravity, and the higher the application the greater the depression. Sulfate of potash did not reduce the specific gravity of the potatoes, indicating that it is the chloride anion which is responsible for increasing the water content of potatoes.

Fertilizer treatment did not appear to influence the occurrence of hollow heart in potatoes.

A correlation coefficient of r=0.8686 between specific gravity and dry matter was found for 260 samples of potatoes from the Red River Valley.

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*Yields given are the averages of three replicates each year.

SECTIONAL NOTES

CALIFORNIA

This is almost the 1st of September, and the harvesting of potatoes in the Tehachapi area is now well under way. There will be approximately 3,000 acres in this area and from all indications, our crop was one of the best crops that this district has ever produced. There is considerable acreage planted in the floor of the valley in fall potatoes. This acreage has not as yet been determined. Many growers are pondering at the present time deciding what to do for 1946. Generally speaking, the growers have their seed ordered. Many have their fertilizer ordered but are still uncertain regarding the acreage they will plant. The 1945 crop, from the standpoint of yield and quality, is one of the poorest that Kern County has ever produced. The average yield per acre has not as yet been compiled.

A new variety known as Calrose has been under development and improvement for the past seven years by Emanuel H. Mettler and Sons of Shafter, California, and has shown great promise this year. It produces a vigorous plant, large root system, small leaves of the Sebago-type feature, and gives a yield equal to or better than the White Rose. The outstanding thing about this plant is the fact that it apparently can be grown later in the season and also harvested later thereby extending the marketing period of new potatoes in Kern County for at least 30 days, and possibly longer. On the 1st of August, ten acres of late-planted Calrose were harvested and yielded approximately 400 sacks per acre. A second 10-acre block is being harvested this next week. These two blocks were planted for the purpose of determining what would happen to the potatoes when permitted to grow in the extreme dry hot weather of this valley. At this time we do not know what the September 1st harvest will be other than the fact that the vines are still in good growing condition. This plant is also quite resistant to late blight. It has been found that where White Rose was killed by late blight that the Calrose continued to grow normally,—especially under California conditions.

You probably will find a considerable tonnage of this crop on the market next year as the seed is being released in this area for the first time this season to other growers. I would suggest that this potato be watched as it approaches the market next year. (Aug. 31)—M. A. LINDSAY.

IDAHO

We were headed for a big crop in Idaho but the frost which came last Sunday and Monday will materially reduce our yield of late

potatoes. Most of the potato vines in the Upper Snake River Valley (which produces perhaps 60 per cent of the potatoes in Idaho) were partially touched and in many cases, completely killed by frost. This killing frost was a week ahead of the average date of our killing frosts and two or three weeks ahead compared with the last two or three years.

The condition of the vines prior to this frost was considerably above the average in that there was very little of this so-called early dying. It is estimated that the yields will be reduced at least ten per cent because of the frost.

Our market conditions at present are fair. Number one's are selling at ceiling prices, but number two's are somewhat below ceiling prices. This, however, is characteristic for this time of the year.

Certified seed acreage is approximately 50 per cent higher than last year and although frosts have been reported in practically all the seed-producing areas, there should be ample certified seed for next year. (Sept. 15)—JOHN L. TOEVS.

INDIANA

So far there is little damage to the potatoes from late blight since most of the blight trouble has seemingly "picked on" the tomatoes. For the past few weeks, the weather has improved and conditions favoring the dissemination of the spores have been unfavorable.

The harvesting operations are now under way and both the yield and quality are high. The commercial crop may exceed 5,000,000 bushels and the home gardener will also reap a good harvest. The markets appear to be well supplied with potatoes with only a fair demand.

No doubt the consumption of potatoes will rise as the points are lowered or removed from butter and meat. "Baked Potato Specials" and "Meat and Potatoes" would help to dispose of any surplus. (Aug. 29)—W. B. WARD.

KENTUCKY

The writer finished first inspection of certified seed potato plantings yesterday and the prospects are fine. The stands are above normal, —averaging well above 90 per cent. Lowest stands (down to 80 per cent) were among the Katahdins because of "blind" pieces when large potatoes were cut to the size of Irish Cobblers. The alternative is to use small potatoes entirely, and this we think perpetuates the diseases that militate against certification; so many of our seed-cutting "hands" cut by rote, too much. Sequoia is exceptionally fine; this variety has

always outyielded Cobblers, especially the late crop, but this year definitely exceeded this variety in the early crop as well. Chippewa is on its way out with us and Warba, too. "Chips" are mainly requested by the potato chip industry, but the general market refuses them because of poor quality.

The acreage for certification this season is only 48,—a drop from the 67 acres obtained in 1944. As furnishing local sources for good seed for Jefferson County's growers, and a few out in the state, we regard certification as still a good project. (Sept. 1)—JOHN S. GARDNER.

NEW JERSEY

Approximately 30 per cent of our crop is still in the ground and growers are very much concerned over the slow movement of their potatoes. The CCC has been purchasing approximately 100 cars of potatoes a week while somewhat less than this quantity is moving in normal trade channels. At this rate our crop will not be moved until January, so that something will have to be done to speed up harvesting. The Commodity Credit Corporation has started purchasing potatoes in barn storage and has just sanctioned the purchase of potatoes placed in piles in approved field storage. The purchase of potatoes in storage will enable growers to harvest their crops as rapidly as they wish and at the same time guarantee a sale for their potatoes. The direct purchase of loaded cars will continue through September.

Blight is still causing some rot in potatoes at destination points, and with the present dull market this condition is making it difficult to move any large quantity of Jersey potatoes to distant markets.

Only 340 acres of second crop potatoes have been entered for certification this year, whereas 470 were entered last year. Plants are very backward due to late plantings brought about by the excessively wet weather at planting time, and a low yield is in prospect unless we have a very late frost. (Sept. 17)—JOHN C. CAMPBELL.

NEBRASKA

Since last reporting the condition of the crop in western Nebraska, conditions have changed materially. By the first of August, the weather was cool and there was sufficient moisture for most of the dry land conditions. Generally speaking, it was ideal potato weather. About the middle of August, the weather became warmer, and the last week was extremely hot; in fact, the hottest period of the entire summer. This spell of hot weather, following cool and extremely favorable conditions, was most damaging to the succulent and rapidly growing potato vines. This hot period lasted about ten days, then suddenly

changed during this past week by rather general rains, which cooled off the entire territory.

The hot dry weather had it's compensations, however, because it checked a serious and general infection of early blight. Had the cool and favorable weather conditions continued, many fields would have been dead before the first of September. It remains to be seen whether this cool and wet period of the last two or three days will again favor the blight, and finally stop the growth of the vines in many cases. Regardless of conditions, reports from most of the dry land areas indicate that above-average yields are in prospect. One hundred bushels per acre are considered normal, and many growers report that 150 bushels should be common. If blight does not affect the irrigated fields, a great many 400-bushel yields will be in prospect. This late rain, above-mentioned, may bring rough potatoes in the dry land areas, where the growth was checked. The additional tonnage that may result from the rain and cool weather may be offset by the poor quality. As a rule, we anticipate good quality on the irrigated areas.

There is very little talk of contracting certified or other potatoes at this time. The early potato areas of central and eastern Nebraska, which we have just finished harvesting, or where harvesting is about completed, have been operating on support prices. In view of the large crop predicted for the country as a whole, the situation does not look very good for the late crop growers. They expect that support prices will be in effect at least at the beginning of the season, but hope that it will improve.

The Nebraska Legislature passed a bill providing for a potato development commission, which commission has been appointed by the governor, and has just begun to function. This commission consists of four growers and three dealers, and the Secretary of Agriculture. Its purpose is to foster any phase of improvement or research or advertising that will improve the potato industry generally. This work will be carried out by means of funds raised by taxation of the industry itself. This tax will consist of ½ cent per cwt. for all potatoes shipped by dealers in the course of the shipping season. It is estimated that at least $20,000 will be available as a result of this program. (Sept. 13)—MARX KOEHNKE.

NEW YORK

The crop report of the first of September, indicates only a slight decrease compared with that of the first of August for New York. This failure to show a more marked decrease must be based on the situation on Long Island and Northern New York where the crop is

reported as being good. Blight and leafhoppers took a heavy toll in the Western and Central part of our state. Yields in Steuben County and on the muck areas are much lighter than was indicated on the 1st of August.

The last two weeks of August and the first two weeks of September were exceptionally dry. This resulted in checking the blight but much damage had already been done by both blight and leafhoppers. Long Island yields are reported to be heavy. The present government direct purchase operations are apparently the result of inadequate farm storage and too many potatoes of poor storage quality from other states on the market at this time. A few Long Island potatoes have been handled in this way.

Upstate growers generally refuse to believe that the New York crop will ultimately prove to be as large as now predicted. An examination of the tubers in many fields during early September has resulted in general disappointment in both size and number.

There has been tremendous interest in the value of DDT for insect control. The Department of Entomology has sponsored many field demonstrations all of which have shown marked results and growers have indicated that they will demand this insecticide next year. Had it been available a month earlier than the first of September this year, the yields in this state could have been greatly increased.

We are cautioning our growers at a full series of field meetings about using vine killers to prevent the spread of tuber blight rot at harvest time and to use every care to avoid bruising of a crop which may have to be harvested in an immature condition. (Sept. 13)—E. V. HARDENBURG.

OHIO

It has been quite dry in most sections of the state for the past four weeks. The rain during the past week came too late for most of the late-planted potatoes. Our Cobbler crop is about double that of last season. Although most of this crop has been harvested, there are still large quantities of Cobblers to be marketed.

The dry weather has not reduced the yield of the Katahdin crop to any great extent but the yields of both Russets and Sebagos will be low.

Because of the wet spring, corn planting was delayed, therefore the corn borer attacked the early potatoes, and caused considerable damage. Some tests with the DDT material showed a substantial reduction in the corn borer population. There were excellent increases

in yield where DDT was available for experimental plots. We have had no outbreak of late blight at the present time.

During the past few days the potato markets have been rather unsettled. The Potato Marketing Association is quoting pecks at 43 cents; 50-pound paper bags, at $1.35; and 100 pounds at $2.55. There is practically no demand for 100-pound bags. The majority of our marketed potatoes have been sold in peck bags. (Sept. 14)—EARL B. TUSSING.

OREGON

Potatoes have made rapid growth in the Klamath Basin during the past two months. However, they have not yet overcome the wet, cold weather experienced during the months of May and June.

The first field inspection was completed early in August,—1800 acres meeting certification requirements. The second field inspection is being conducted at the present time.

It is expected that yields will be considerably below average unless frost-free conditions should continue extremely late in the fall. (Aug. 30)—C. A. HENDERSON.

OREGON

We have a larger acreage of potatoes to inspect in Oregon this year for certified seed than we have ever had. Our total acreage of certified seed, however, is not likely to be any higher than last year because of the large numbers of rejections caused by leafroll. We are having the worst epidemic of leafroll that we have ever experienced. Although leafroll has always been present, it has never spread so rapidly as it seems to be doing now. I do not know whether we have a different and more virulent strain of leafroll or whether conditions this year are more favorable for its spread. In any case, this year for the first time, rejections in the field because of leafroll will far exceed rejections due to mosaic.

We are also finding a little more ring rot than has been the case for the last year or two. In most cases it is not plentiful, but we will have one-half dozen fields averaging eighty acres that will be rejected because of finding one lone plant affected with ring rot.

The commercial acreage in the state is at a point considerably higher than normal and exceeds fifty thousand acres. Many years previously we have been growing from forty to forty-five thousand acres. The larger acreage was stimulated by a tight potato situation here in recent years caused by large purchases for dehydrating plants and for Army and Navy use. Also all three Pacific Coast states had populations swollen by war workers in shipyards, airplane factories, and

munitions plants. These people are drifting away from the Coast rather fast now, but many want to stay here if they can find work. The potato acreage on the Pacific Coast, therefore, may be on a permanently expanded basis. (Sept. 6)—E. R. JACKMAN.

SOUTH DAKOTA

Potato harvesting is now in full swing in South Dakota (Sept. 17, 1945), and yields are extra good. Many fields of certified Triumphs, Pontiacs and Red Warbas are yielding from 200 to 250 bushels per acre. Most of the fields are free from late blight but the low places in some fields have to be checked frequently. Certified Triumphs and Pontiacs have been shipped to southern Florida, and some exports have been sent to Cuba.

Labor is still scarce. One hundred Mexican Nationals are helping in the Watertown area but labor around Clark and Garden City, the largest producing areas, is in a critical condition.

Lack of storage space will force much good certified stock on markets this fall. Growers hope the government will buy in this area to support prices. Growers with storage can take advantage of the loan program. (Sept. 16)—JOHN NOONAN.

CANADA

The Canadian Department of Agriculture reports an increase in the acreage entered for certification of approximately 57 per cent or 48,700 acres compared with 31,633 acres entered in 1944. More than one-half of this acreage is in Prince Edward Island where almost 25,000 acres were entered. New Brunswick entered approximately 18,000 acres for inspection this year and, therefore, these two provinces account for nearly 90 per cent of the certified acreage. The acreages entered are: Green Mountains, approximately 14,500 acres; Cobblers, 13,700; and Katahdins, 10,500 acres; whereas only 48 acres of Chippewas were entered for certification.

Since climatic conditions on Prince Edward Island were very dry during the months of July and August, their production of Cobblers is estimated at only slightly above last year's figure. However, rains during the latter part of August proved beneficial to the Green Mountain and Katahdin varieties and these varieties will, consequently, produce a more normal yield. Most of the fields are passing inspection, since the disease incidence is very low. (Sept. 17) (Abs. by JOHN C. CAMPBELL).

BATEMAN-IRON AGE GARDEN TOOLS

On July 1 the name Iron Age will be dropped. This line has been made by the Bateman family for 108 years and now owned and manufactured by the fourth generation. The name Bateman will be the trade name for these garden tools in the future.

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There will be no other change in trade names of the individual tools or part numbers.

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FERTILIZER PLACEMENT FOR POTATOES: A COMPARISON OF LEVEL-BAND AND HI-LO METHODS[1]

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The results of five years' experimental work (1931-35), comparing different methods of fertilizer placement for the potato crop, showed conclusively that in the great majority of tests conducted, placement of fertilizer in side bands gave best returns. The findings have been presented in different publications (1, 2, 3, 4)[5] and a definite recommendation was made officially as follows (5):

[1]In collaboration with the late Fred H. Bateman, of the A. B. Farquhar Manufacturing Company, York, Pa., an enthusiastic supporter of fertilizer placement work in general, and especially interested in fertilizer placement studies with potatoes.

[2]Research Associate in Agriculture.

[3]Respectively: Assistant soil scientist and senior biochemist.

[4]Head, Department of Crops and Soils.

[5]Figures in parentheses refer to "Literature Cited" at close of article.

> Fertilizer should be applied in bands on each side of the seed piece with two inches of fertilizer-free soil interposed. The fertilizer bands should be on a level with or slightly below the seed piece. On sloping land, in order to avoid fertilizer shifting too close to the seed it is recommended that the depth of fertilizer placement be about an inch below the seed level.[6]

Since the foregoing official recommendation was made, other methods of fertilizer placement for potatoes have been suggested. Chief among them have been the so-called "Hi-Lo" method and another which places part or all of the fertilizer at plow-depth. With reference to the Hi-Lo method of fertilizer placement, Mr. Bateman had made the suggestion that, instead of applying the fertilizer in level bands, one band might be placed 2 to 3 inches below the seed-piece level and the other band level with it. His thought was that during dry spells, if the moisture content of the upper surface of the soil were lowered below the needs of the potato plants, the presence of more moisture at lower depths might tend to insure greater availability of the added plant nutrients. In view of the long association of Mr. Bateman with the writers in their potato fertilizer placement studies, and because his suggestion merited experimental study, field experiments were established in 1940 in Middlesex County, New Jersey, on Sassafras loam and in Aroostook County, Maine, on Caribou loam to compare the standard method with the suggested Hi-Lo method of fertilizer placement. The field comparisons were made over a 3-year period, 1940-'42, the greatest number of direct comparisons both in New Jersey and Maine having been made in 1940 and 1941.

Result of Other Studies Comparing Level-Band and Hi-Lo Fertilizer Placement for Potatoes

Smith (6), of the New York (Cornell) Agricultural Experiment Station, conducted some interesting studies on potatoes in 1942 including fertilizer placement and rate of fertilizer application in conjunction with variety, seed spacing, and size of seed piece. As his findings have been presented in detail (6), the writers do not feel that it is necessary to do more than present general averages of the yields obtained for all his tests. He compared the equal-depth band method, or standard level-band method, with a Hi-Lo method twenty times. For the twenty

[6]This particular method is referred to throughout this paper as "standard level-band method."

comparisons the standard level-band method yielded at the average rate of about 265 bushels and the Hi-Lo at 288.5 bushels per acre, a difference of 23.5 bushels in favor of the Hi-Lo method.

Smith, Kelly, and Hommel (7), of the New York (Cornell) Agricultural Experiment Station, conducted further studies in 1943 that dealt with the relation of fertilizer placement, rate of fertilizer application, source of nitrogen and potassium, irrigation, and seed-piece spacing to yields of potatoes. Their results showed that the average yield of 29 comparisons was 235.3 bushels per acre for the standard level-band method of fertilizer placement compared with 240.8 bushels for the Hi-Lo method,[7] a difference of 4.7 bushels per acre in favor of the Hi-Lo method. Thus, in 1942, on the basis of an over-all average, the Hi-Lo method was shown to be the better method of fertilizer placement for potatoes; in 1943 the Hi-Lo method was slightly better. Smith (8) later discusses the results in a general report made on potato fertilizer and nutrition studies.

Rainfall Records—New Jersey and Maine

Obviously, the amount and distribution of rainfall are influential factors in crop production, particularly so for the potato crop. For this reason it was felt that a presentation of the rainfall records is desirable before consideration of the field results. From an examination of table 1, wherein rainfall records are given for three growing seasons (April through August in New Jersey and May through September in Maine), it will be noted that only in 1942 was there a deficiency of rainfall in both locations. The deficiency for the 5-month period in New Jersey was 5.47 inches; in Maine, 2.46 inches. It would seem logical to assume therefore that if there were any advantage in placing one band of fertilizer lower by 2 or 3 inches than the standard band placement, then 1942 should be the year when the alleged advantage would be apparent. Particularly would this condition tend to prevail in New Jersey where a much greater deficiency of rainfall was registered for the growing season, 5.47 inches, than in Maine, with a deficiency of 2.46 inches. Further reference to the rainfall factor will be made in the discussion of the results obtained with the standard and Hi-Lo methods of fertilizer placement in the two locations.

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[7] Lo-band presumably about 2 inches below lower plane of seed piece.

TABLE 1. *Rainfall records for New Jersey*[8] *and Maine*[9]—1940-1942 *New Jersey Records, April-August; Maine records, May-September*

Month	Period	Rainfall Records—New Jersey			Rainfall Records—Maine		
		1940	1941	1942	1940	1941	1942
		Inches	Inches	Inches	Inches	Inches	Inches
Apr.	1- 7	.36	1.64	—	—	—	—
Apr.	8-14	3.00	—	1.2	—	—	—
Apr.	15-21	1.75	—	—	—	—	—
Apr.	22-30	.16	.53	.02	—	—	—
Total		5.27	2.17	1.22			
Normal		3.89[10]					
May	1- 7	.42	.19	.47	.59	.08	.03
May	8-15	.28	.60	.27	.07	.24	.51
May	15-21	3.06	.53	.68	.98	1.61	.20
May	22-31	2.96	2.23	.36	.43	.72	.73
Total		6.72	3.55	1.78	2.07	2.65	1.47
Normal		3.61[10]			2.75[10]		
June	1- 7	.04	2.45	.26	1.21	—	.26
June	8-14	—	1.64	1.45	1.25	1.03	.07
June	15-21	.22	.20	.32	2.00	.30	2.39
June	22-30	1.63	.46	.36	3.05	2.39	.45
Total		1.89	4.75	2.39	7.51	3.72	3.17
Normal		4.28[10]			3.60[10]		
July	1- 7	.64	5.64	2.26	.48	—	.34
July	8-14	.63	2.07	.52	.21	2.56	.31
July	15-21	—	.44	.76	.19	.44	1.23
July	22-31	.47	.61	2.70	2.53	.30	.04
Total		1.74	8.76	6.24	3.41	3.30	1.92
Normal		4.92[10]			3.62[10]		

July	22-31	.47					
Total		1.74	8.76	6.24	3.41	3.30	1.92
Normal		4.92[10]			3.62[10]		

TABLE 1. *Rainfall records for New Jersey*[8] *and Maine*[9]—1940-1942 *New Jersey records, April-August; Maine Records, May-September (Continued)*

Month	Period	Rainfall Records—New Jersey			Rainfall Records—Maine		
		1940	1941	1942	1940	1941	1942
		Inches	Inches	Inches	Inches	Inches	Inches
Aug.	1- 7	.99	.65	.72	.13	1.31	1.48
Aug.	8-14	.14	.23	2.76	.51	.68	2.05
Aug.	15-21	2.41	.98	.46	.62	.53	.6
Aug.	15-21	3.10	1.64	.69	.41	2.01	—
Total		6.64	3.50	4.63	1.67	4.53	4.13
Normal		5.03[10]			2.97[10]		
Sept.	1- 7	—	—	—	.78	1.02	.13
Sept.	8-14	—	—	—	.19	.43	.61
Sept	15-21	—	—	—	1.62	.98	.76
Sept.	22-30	—	—	—	1.78	.05	1.61
Total					4.37	2.48	3.11
Normal					3.32[10]		
Total—5 mos.		22.26	22.73	16.26	19.03	16.68	13.80
Normal—5 mos.		21.73	21.73	21.73	16.26	16.26	16.26
Departure from Normal		+.53	+1.0	—5.47	+2.77	+.42	—2.46

[8]New Jersey rainfall records for 1940 were taken at Hightstown, N. J., about 10 miles from Perrine Farm, by U. S. Weather Bureau, Department of Commerce; 1941 and 1942 records were taken on the Hulse Farm, near Perrine's, with Standard U. S. rain gauge.

[9]Rainfall records for Maine locations were taken at Aroostook Farm, Maine Agricultural Experiment Station; Duncan Farm was about ½ mile from Aroostook Farm and the Burgess Farm about 8 miles from Aroostook Farm.

[10]Normal rainfall for month.

Field Studies in New Jersey Comparing Standard Level-Band and Hi-Lo Placement Methods

The following fertilizer placement methods were compared on the farm of Spencer Perrine near Cranbury, New Jersey, during 1940 and 1941 on Sassafras loam.

1. Standard level-band method. Fertilizer placed in equal-quantity bands 2 inches to side of and level with the lower plane of the seed piece. See Fig. 1, (1).

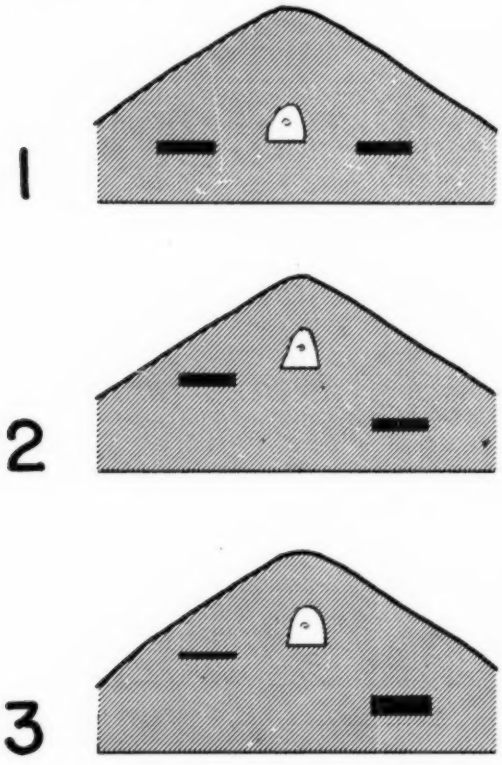

Figure 1.—ILLUSTRATING DIFFERENT METHODS OF FERTILIZER PLACEMENT:

1. Fertilizer applied in a band on each side of seed piece, 2 inches from and on a level with lower plane of seed piece. Same quantity of fertilizer in each band. (The depth of planting was actually the same as in 2 and 3, not at the greater depth shown in the diagram.)
2. Hi-Lo method. Hi band of fertilizer in same position as in 1. Lo band 2 inches to side and 2 inches below lower plane of seed piece. Same quantity of fertilizer in each band.
3. Hi-Lo unequal-quantity method. Hi band of fertilizer in same position as in 1 and 2, with 25 per cent of fertilizer. Lo band, same position as in 2, with 75 per cent of fertilizer.

2. Hi-Lo method. Fertilizer placed in equal-quantity bands, Hi band same as 1 above, Lo band 2 inches below the seed-piece level. See Fig 1, (2).
3. Hi-Lo method. Fertilizer placed in equal-quantity bands. Hi band same as 1 above. Lo band 3 inches below seed-piece level.
4. Deep-band placement. Fertilizer placed in equal-quantity bands. Both bands two inches to each side of and two inches below seed-piece level.
5. Deep-band placement. Fertilizer placed in equal-quantity bands. Both bands two inches to each side of and three inches below level of seed piece.
6. Unequal-band placement. Both bands placed as in 1, above, with one-fourth of fertilizer in one band, three-fourths in the other.
7. Hi-Lo method. Hi band placed as in 1, above. One-fourth of fertilizer in Hi band, three-fourths in Lo band two inches below seed piece level. See Fig. 1, (3).
8. Hi-Lo method. Same as 7 with fertilizer in Lo band three inches below seed piece level.

It will be noted in table 2 that the majority of placement methods compared in 1940 and 1941 were discontinued in 1942 and that only two placement comparisons were made in the latter year, namely, the standard level-band method and the Hi-Lo method, which placed the Lo band 2 inches below the seed piece with the same quantity of fertilizer in each band. As previously listed these are methods 1 and 2.

The results obtained with the Irish Cobbler variety in New Jersey in a comparison of the foregoing placement methods are given in table 2.

Discussion of Fertilizer Placement Results Obtained in New Jersey

In 1940 the standard level-band method produced a yield of 282 bushels per acre, the highest yield recorded for any of the placement methods compared (see table 2). In 1941, the standard level-band method produced 289 bushels per acre, being exceeded by three Hi-Lo methods (Nos. 2, 7, and 8). The No. 2 Hi-Lo method, with the fertilizer placed in equal-quantity bands but with the Lo band 2 inches below the level of the seed piece, produced only 2 bushels more than the standard method. The No. 7 method, which placed the fertilizer in unequal quantity bands, 25-75, with the Lo band two inches below the seed piece, gave a yield of 300 bushels per acre,—an increase of 11

TABLE 2. *Potato yields obtained in New Jersey in a comparison of standard level-band and Hi-Lo fertilizer placements, Irish Cobbler variety.*[1]

Placement Method Number	Depth of Fertilizer below Seedpiece	Relative Quantity of Fertilizer in Bands	Average Yield per Acre			General Average	
			1940	1941	1942	2 Years 1940-'41	3 Years 1940-'42
	Band	Band	Bu.	Bu.	Bu.	Bu.	Bu.
	1 *2*	*1* *2*					
1	0 — 0[2]	50 — 50	282	289	332	285.5	301
2	0 — 2[3]	50 — 50	270	291	308	280.5	290
3	0 — 3[3]	50 — 50	256	284	—	270	—
4	2 — 2[4]	50 — 50	275	286	—	280.5	—
5	3 — 3[5]	50 — 50	270	273	—	271.5	—
6	0 — 0[2]	25 — 75	259	288	—	273.5	—
7	0 — 2[3]	25 — 75	270	300	—	285.0	—
8	0 — 3[3]	25 — 75	265	304	—	284.5	—

[1]A 5-10-10 fertilizer was employed in the New Jersey studies at the uniform rate of 1,600 pounds per acre. The fertilizer was formulated as follows: Nitrogen derived ¼ from sodium nitrate, ½ from ammonium sulfate, 1/8 from Uramon, 1/8 from fish scrap. Phosphorus derived from super-phosphate (19.3 per cent P_2O_5) Potash from muriate of potash (51.9 per cent K_2O). Small quantity of sand used for filler.

[2]Standard level-band placement. A band on each side of seed piece two inches from and level with lower plane of seed piece.

[3]Lo band below seed-piece level, two inches and three inches, respectively for the paired treatments.

[4]Both bands of fertilizer two inches to each side and two inches below seed-piece level.

[5]Both bands of fertilizer two inches to each side and three inches below seed-piece level.

bushels per acre compared with the yield of the standard level-band method. The No. 8 method, which placed the Lo band three inches below the seed piece, produced a yield of 304 bushels per acre,—an increase of 15 bushels per acre over the standard level-band method.

In 1942, the standard level-band method outyielded the Hi-Lo method by 24 bushels per acre. The average 3-year yields of these two particular methods was 301 bushels per acre for the standard method and 290 bushels per acre for the Hi-Lo method. A comparison of these two methods for the three-year period shows that the standard level-band method gave higher yields in 1940 (12 bushels per acre increase); a slightly lower yield in 1941 (2 bushels per acre decrease); and in 1942 the standard level-band method gave a higher yield by 24 bushels per acre than did the Hi-Lo method.

When the Lo band (method No. 3) was placed 3 inches below the seed piece, the 2-year average yield was 270 bushels per acre whereas the standard method produced at the average rate of 285.5 bushels per acre,—an increase of 15.5 bushels in favor of the latter method. Placing both fertilizer bands either 2 or 3 inches below the seed piece (Methods Nos. 4 and 5) lowered the yield 5 bushels and 14 bushels per acre, respectively, below that of the standard level-band method.

Discussion of New Jersey Rainfall Records—1942

In 1942, notwithstanding a deficiency of rainfall amounting to 5.47 inches for the 5-month period, April-August, a yield difference of 24 bushels per acre was registered in favor of the standard level-band method. In view of this fact it may be desirable to consider the 1942 season in some detail. The potatoes, Irish Cobbler variety, were planted on the 23-24th of April and harvested on the 6th and 7th of August,—a period of about 104 days. From an examination of the New Jersey rainfall records (table 1) it will be noted that April was a comparatively dry month with only 1.22 inches of rainfall, most of which fell during the period April 8-14 (1.2″). This meant a deficiency of 2.67 inches for April. By the end of May the potato plants should have emerged. May rainfall was also 1.83 inches less than normal, but it was fairly well distributed. In June, with a normal rainfall of 4.28 inches, another deficiency was registered, amounting to 1.89 inches. The 1.45 inches of rain recorded for the second period in June no doubt served to tide over the growing crop, and with some rainfall preceding and following probably enabled it to carry on until the comparatively heavy rainfall during the first period in July, amounting to 2.26 inches. Rainfall for July as a whole was more than adequate—6.24 inches total, an excess precipitation of 1.32 inches for the month.

During the first period of August, the final period before harvest, .72 inch of rain was recorded which was preceded by 2.7 inches during the last period of July. Thus it will be seen that although the rainfall for the entire period was 5.47 inches below normal and all of this was experienced during April, May, and June, the fairly well distributed rainfall of June, followed by more than ample rainfall in July apparently enabled this potato crop to end the season with the highest yield of any of the three years the experimental work was conducted. It would seem fairly obvious, therefore, that total rainfall during any growing period can be overshadowed in importance by rainfall distribution, which, in 1942 was favorable for comparatively high yields.

Field Studies in Maine Comparing Standard Level-Band and Hi-Lo Placement Methods

The following fertilizer placement methods were compared on different farms in Aroostook County, Maine, in 1940 and 1941, on the Caribou loam soil type:

1. Standard level-band method. Fertilizer placed in equal-quantity bands, 2 inches to the side of and level with the lower plane of seed piece. See Fig. 1, (1).
2. Hi-Lo method. Fertilizer placed in equal-quantity bands. Hi band same as 1, above. Lo band, 2 inches below the seed piece level. See Fig. 1, (2).
3. Hi-Lo method. Fertilizer placed in equal-quantity bands. Hi band same as 1 above. Lo band 3 inches below seed piece level.
4. Hi-Lo method. One-fourth of fertilizer in Hi band at seed piece level, three-fourths in Lo band, 2 inches below seed piece level. See Fig. 1, (3).
5. Hi-Lo method. One-fourth of fertilizer in Hi band at seed piece level, three-fourths in Lo band, 3 inches below seed piece level.

The rate of fertilizer application in placements Nos. 1-5 was 1000 pounds per acre, but in placements Nos. 6-10 the rate of application was 1500 pounds per acre. In 1942 only four fertilizer placement comparisons were made. The results obtained with the Green Mountain variety are given in table 3.

Discussion of Fertilizer Placement Results Obtained in Maine

An examination of the yields obtained in a three-year test of standard level-band fertilizer placement in comparison with the Hi-Lo band method serves principally to show that no positive advantage accrued from the Hi-Lo method even in 1942, a year of less rainfall than either 1940 or 1941.

TABLE 3. *Potato yields obtained in Maine in a comparison of standard level-band and Hi-Lo fertilizer placement, Green Mountain variety.*

Fertilizer Placement Number[12]	Depth of Fertilizer below Seed Piece[13] Inches		Relative Quantity of Fertilizer in Each Band		Average Yield per Acre					Average Results	
	Band		Band		1940			1941	1942	2 Yrs. 1940-'41	3 Yrs. 1940-'42
	1	2	1	2	Farm 1 Bu.	Farm 2 Bu.	2 Farms Ave. Bu	Bu.	Bu.	Bu.	Bu.
1	0	0	50	50	347	311	329	405	404	354	367
2	0	2"	50	50	333	303	318	402	—	346	—
3	0	3"	50	50	352	—	—	392	—	—	—
4	0	2"	25	75	363	315	339	394	355	357	357
5	0	3"	25	75	339	—	—	408	—	—	—
6	0	0"	50	50	341	338	339.5	413	403	364	373
7	0	2"	50	50	338	302	320	390	—	343	—
8	0	3"	50	50	335	—	—	424	—	—	—
9	0	2"	25	75	343	318	330.5	397	388	353	361
10	0	3"	25	75	349	—	—	380	—	—	—

[12]Placements 1-5, 1000 pounds of double-strength fertilizer per acre; Placements 6-10, 1500 pounds per acre.
[13]An 8-16-20 analysis used in all placement tests. In 1941 an additional analysis, 8-12-20 was also used. The fertilizers used were formulated as follows: Sodium nitrate, fish scrap, and ammonium sulfate as primary sources of N; Ammo-Phos B furnished P_2O_5 and some N; potassium nitrate furnished a portion of the potash (K_2O) and some N; bulk of potash (K_2O) derived from muriate of potash.

In 1940, on the basis of average results for two farms, the standard level-band method with double-strength fertilizer applied at the rate of 1,000 pounds per acre produced a yield of 329 bushels per acre (table 3). This was 10 bushels less than from the Hi-Lo placement method No. 4 which placed 25 per cent of the fertilizer level with the seed piece and 75 per cent 2 inches below, but was 11 bushels more than from the Hi-Lo method No. 3 with a 50-50 distribution in the bands. When the fertilizer rate was increased to 1,500 pounds of double-strength fertilizer per acre, the standard level-band method produced the highest yield, 339.5 bushels, which exceeded Hi-Lo method No. 7 by 19.5 bushels per acre, and Hi-Lo method No. 9 by 9 bushels per acre.

In 1941, two tests were conducted on one farm, using two fertilizers, namely 8-12-20 and 8-16-20. It will be noted from the average yields in table 3 that, with but two exceptions, the standard level-band placement gave higher yields. Finally, in 1942, when only one comparison for each of the two fertilizer rates was made, the standard level-band placement assumed first rank. On the basis of the two-year averages, 1940-1941[14], there were only slight yield differences with the 1,000-pound rate of fertilizer application but with the 1,500-pound rate the standard level-band method outyielded the two Hi-Lo placements Nos. 7 and 9 by 21 and 11 bushels, respectively, per acre. On the basis of the 3-year comparisons the standard method gave yields that were 10 and 12 bushels per acre higher, respectively, for the two fertilizer rates, than those from Hi-Lo method No. 4 with 75 per cent of the fertilizer placed 2 inches below the seed-piece level.

Discussion of Maine Rainfall Records

The rainfall at the Maine location (Aroostook Farm of the Maine Agricultural Experiment Station) was above normal in 1940 (+2.77 inches) and in 1941 (+0.42 inch) for the 5-month period May-September; but in 1942 there was a moderate though hardly serious deficiency of rainfall (—2.46 inches) for the same seasonal period. As was the case in the New Jersey studies for the same year (1942), when a deficiency of 5.47 inches was recorded for the April-August 5-month period, it might have been anticipated that in Maine, too, the advantage of Hi-Lo fertilizer placement might show to better advantage in 1942 than in the more nearly normal rainfall seasons of 1940 and 1941. From an inspection of the 1942 rainfall records for Maine (table 1), it is questionable whether a deficiency of 2.46 inches had any unfavorable effect upon the potato crop. May was a comparatively dry month

[14]Averages for three tests only.

with a deficiency of 1.28 inches of rainfall. However, the potatoes, Green Mountain variety, were planted late[15] and it is reasonable to assume that the moisture condition of the soil was good following the rainfall of 0.73 during the last period of May. A heavy preciptation during the third period in June (2.39 inches), with showers before and after, served to keep the June rainfall close to normal, with a deficiency of only 0.43 inch for the month. July, however, was deficient in rainfall by 1.7 inches; but showers fell during the first two periods of the month, followed by a good rain of 1.23 inches in the third period. The rainfall in August was very satisfactory, with 1.48 and 2.05 inches during the first and second periods, respectively, and 0.6-inch for the third period, giving August an above-normal rainfall of 1.16 inches. This meant that the crop was not suffering from lack of moisture at the end of August; and with a practically normal rainfall during September the season of 1942 may be considered as having been a very good one for the potato crop in Aroostook County, inasmuch as it proved to be one of the best crops on record with respect to both yield and quality. The yields in 1942 were higher than those of 1940 and were on a par with those of 1941, in both of which seasons rainfall was above normal. It is obvious again that deficiency in total rainfall during a given period may be compensated for through a normal distribution of the rainfall.

Relative Merits of Standard Level-Band and Hi-Lo Fertilizer Placement

The writers have no hesitancy in stating that while the Hi-Lo method may be all right in principle, yet it has serious shortcomings in practice. The main difficulty both in Maine[16] and in New Jersey was the annoying breakage of the large disk essential to the low-depth placement of fertilizer in the Lo band. To place fertilizer 2 to 3 inches under the seed-piece level proved to be quite a strain on the planter. A sudden quick lurch of the planter, or hitting a large rock, often caused the disk to snap. This meant loss of time and time is very valuable when planting. Also, from time to time in New Jersey, besides breaking of the disk, trouble and delay were experienced in attempting to place the fertilizer at a low depth because the plowed-under rye or other cover crop was turned up on top of the seed bed.

Summary

In recent years much interest has been taken in the placement of fertilizers for the potato crop. The results of several years' field

[15]Planted June 6, harvested soon after a killing frost on September 26.
[16]Particularly true of the rocky Caribou loam in Aroostook County, Me.

work, 1931-35, showed that of the 6 or 7 methods of placement compared, the most profitable method was the one which placed the fertilizer in a band on each side of the seed piece, two inches therefrom and on a level with or slightly below the lower plane of the seed piece. Accordingly this particular method was officially recommended by the National Joint Committee on Fertilizer Application and it is the one that has been generally adopted by potato growers and machinery manufacturers alike. Since the general adoption of this method, other methods have been suggested for the potato crop. One of them, the so-called Hi-Lo method, is reputed to have an advantage from placing one of the fertilizer bands two to three inches below the seed piece level into presumably more moist soil in order to better maintain its nutrient availability to the potato plants should dry weather prevail. Another suggested change involved placing more of the fertilizer in the lower band than in the upper one, such as the 25-75 per cent fertilizer distribution considered in the present tests.

A three-year comparison of the standard level-band and different Hi-Lo placements was made on Sassafras loam in New Jersey and on Caribou loam in Aroostook County, Maine. Notwithstanding the fact that the rainfall in 1942, on the basis of total rainfall for the growing season, was below normal, the net result was that none of the variations of the Hi-Lo method of fertilizer placement was consistently superior to the standard level-band placement method. On the other hand, if anything positive can be derived from the experimental work reported herein, it is that the standard level-band method produced the highest yields in the majority of the comparisons made, under soil and seasonal conditions prevailing in two widely separated locations, Maine and New Jersey. Furthermore, in the practical evaluation of these two placement methods, it should be considered that certain mechanical difficulties are involved in any attempt to place fertilizer 2 to 3 inches below the seed-piece level. To do so requires a larger disk which is subject to breakage in rocky soil or for other causes, with consequent loss of valuable time to make replacements during the planting period. As no such difficulty is encountered in using the standard level-band method, potato growers are generally inclined to favor this particular method of fertilizer placement.

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THE EFFECT OF PREVIOUS STORAGE TEMPERATURES ON THE QUALITY OF DEHYDRATED POTATOES

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Since the beginning of the war many investigations have been made on various problems related to the dehydration of white potatoes. Most of these studies have dealt mainly with the mechanics of dehydration, and much less attention has been given to the effects of storing or handling of the raw stock on the quality of the finished dehydrated product.

There is normally little sugar in potatoes when they are dug. A number of investigations [2], [3], [4], have shown that the sugar content of stored potatoes is related to the temperature at which they are held. If stored at temperatures lower than about 45° to 50° F. the sugar content increases and the table quality of the potatoes is correspondingly lowered. Appleman (1) reported that as the storage season advanced from November 28 to February 13 and the temperature in common storage decreased from 42° to 29° F. the total sugar in the potatoes increased from 1.10 to 4.15 per cent. Sweetman (5) showed that potato chips made from stock stored at temperatures between

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32° and 37° were darker and less desirable than those from stock stored at 60°. Investigations reported by Wright *et al.* (4) showed that with several varieties of potatoes stored at 32°, 36°, 40°, 50°, and 60° the sugar content varied from 5 to 7 per cent at 32° to as low as one-half per cent or less at 60°. Furthermore, when cooked the consistency varied from very soggy in potatoes from 32° and 36° storage, to various degrees of desirable mealiness, depending on the variety, in those from 50° and 60°, whereas 40° material was judged as intermediate. When made into French fries or chips the most satisfactory results were obtained in potatoes from 50° and 60° storage. When the tubers came from 40° storage these products tended to be more or less undesirably brown and barely edible. These products from potatoes held at 36° or 32° storage were extremely undesirable because of the dark brown color and burned taste due to caramelization of such a large amount of sugar.

Since the war has made the dehydration of potatoes a major industry, this study was undertaken to determine whether the principles previously discovered in relation to culinary quality likewise apply to dehydrated potatoes. Potatoes of known variety and history were stored at different temperatures and later dehydrated under like conditions. In brief, the results showed that quality of the dehydrated product was affected by conditions under which the raw stock was stored in much the same way as was found for potatoes not dehydrated.

Materials and Methods

In the first test, potatoes of the Katahdin, Sebago, Chippewa and Dakota Red varieties grown in Maryland were used. Immediately after harvesting they were brought to the Plant Industry Station laboratory at Beltsville, Maryland, and equivalent lots of each variety were stored at 32°, 40°, 50°, and 60° F. This represents a range of temperatures wide enough to cover all those ordinarily encountered in commercial practice. The potatoes were sampled for analysis prior to storing and each of the stored lots of potatoes was sampled after 10 weeks and again after 16 weeks. In addition, supplementary lots of each variety were left in the 60° storage for a three weeks' "curing" period immediately after harvesting and then transferred to 40° and 32°. After 10 and 16 weeks or after total holding of 13 and 19 weeks these were sampled in the same manner as the lots that had been held continuously at 32°, 40°, 50°, and 60°.

At the first sampling the Chippewa tubers in 32° F. storage were found to be so badly discolored by the so-called "Mahogany browning" that all of this variety at this temperature were discarded. A limited

amount of "blackheart" was found in a few tubers of the Katahdin and Sebago varieties at 32°. The Dakota Red tubers appeared watery when cut but no discoloration defects were found. After 16 weeks at 32° "black-heart" had rendered most specimens of the Katahdin variety unfit for sampling. This condition was rarely noted in the Sebago and not at all in the Dakota Red variety. At other temperatures than 32° no visible changes were noted except that at 60°, after 16 weeks, sprout growth was apparent on all varieties.

In another test, Maine-grown potatoes of the Katahdin, Sebago, Chippewa, and Bliss Triumph varieties were used. They were harvested toward the last of September and held at approximately 50° F. until shipped to the Beltsville laboratory, where they were received on the 1st of November and stored under the same conditions as described for the Maryland-grown potatoes. Part of these were sampled for sugar and also dehydrated after 8 weeks of additional storage; the remaining material was dehydrated after 16 weeks but not sampled for sugar. As with the Maryland-grown Chippewa potatoes, many showed Mahogany browning in 32° after 8 weeks' storage. On this account none of this lot was dehydrated but sugar determinations were made. The appearance of all the other lots remained unchanged in storage.

Sugar Determinations

In determining the sugar content, a slice one-quarter inch thick was cut longitudinally from the center of each of 10 tubers uniform in size. Each lot of 10 slices was ground in a food grinder and then the ground-up pulp was homogenized in a laboratory blender. Fifty-gram duplicate samples were then quickly weighed out and brought to a boil in about 200 ml. of 95 per cent alcohol. After cooling, the volume was brought to 500 ml. and allowed to stand until the end of the storage season. Reducing sugar was determined in an aliquot of the filtrate essentially by the Munson and Walker method. Total sugar was determined after hydrolysis of another aliquot with hydrochloric acid; after neutralizing, the procedure was the same as for reducing sugar. Sucrose was determined by difference between the total and the reducing sugar values.

In tables 1 and 2 are shown the percentages of total sugar, reducing sugar, and sucrose found at the respective sampling periods. In all the Maryland-grown varieties the sugar content remained practically unchanged during storage at 50° and 60° F. In all varieties the total sugar content at these two temperatures remained below 0.5 per cent. In 40° storage there was a distinct but not great increase over the pre-storage total sugar value, the amount varying between 1.1 to 1.6 per

TABLE 1. *Sugar content (expressed as dextrose) of Maryland-grown potatoes before storage and after 10 and 16 weeks at four different storage temperatures; also after being "cured" at 60° for 3 weeks and then stored at 40° and 32° F. for the same periods.*

Variety	Storage Temperature	After 10 Weeks			After 16 Weeks		
		Total	Reducing	Sucrose	Total	Reducing	Sucrose
	° F.	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Katahdin	At start[1]	0.09	0.02	0.07	—	—	—
	60	0.06	0.01	0.05	Sprouting		
	50	0.26	0.11	0.15	0.10	0.01	0.09
	40	1.31	0.85	0.46	1.20	0.77	0.43
	32	7.03	2.03	5.00	—Decayed		
	40 Cured	1.52	0.65	0.87	1.84	0.91	0.93
	32 Cured	7.03	1.98	5.05	7.97	3.36	4.61
Sebago	At start[1]	0.45	0.10	0.35	—	—	—
	60	0.19	0.05	0.14	Sprouting		
	50	0.31	0.14	0.17	0.27	0.19	0.08
	40	1.46	0.71	0.75	1.45	1.14	0.31
	32	6.36	1.95	4.41	7.31	4.04	3.27
	40 Cured	1.60	0.35	1.25	1.74	0.68	1.06
	32 Cured	7.61	2.42	5.19	7.75	4.01	3.74
Chippewa	At start[1]	0.15	0.01	Trace	—	—	—
	60	0.09	0.02	0.07	Sprouting		
	50	0.18	0.07	0.11	0.20	0.01	0.19
	40	1.09	0.57	0.52	0.50	0.50	Trace
	32	—	Decayed		Decayed		
	40 Cured	1.63	0.82	0.81	1.24	0.87	0.37
	32 Cured	6.27	1.69	4.58	—	—	—
Dakota Red	At start[1]	0.15	0.01	0.14	—	—	—
	60	0.19	0.03	0.16	Sprouting		
	50	0.41	0.22	0.19	0.30	0.22	0.17
	40	1.61	0.74	0.87	0.16	0.72	0.44
	32	5.73	2.78	2.95	6.03	3.82	2.21
	40 Cured	1.20	0.54	0.66	1.33	0.71	0.62
	32 Cured	6.34	2.24	4.10	7.32	3.57	3.75

TABLE 2. *Sugar content (expressed as dextrose) of Maine-grown potatoes after 8 weeks' storage at different storage temperatures.*

Variety	Storage Temperature	After 8 Weeks Continuous Storage		
		Total	Reducing	Sucrose
Katahdin	° F.	Per cent	Per cent	Per cent
	60	0.13	0.09	0.04
	50	0.48	0.36	0.12
	40	1.39	0.95	0.44
	32	5.31	2.22	3.09
Sebago	60	0.14	0.06	0.08
	50	0.25	0.12	0.13
	40	1.34	0.88	0.46
	32	5.45	1.63	3.82
Chippewa	60	0.12	0.06	0.06
	50	0.25	0.19	0.06
	40	1.08	0.82	0.26
	32	4.87	1.84	3.03
Bliss Triumph	60	0.40	0.25	0.15
	50	0.81	0.66	0.15
	40	1.46	1.28	0.18
	32	5.47	2.67	2.80

cent. In 32° after 10 weeks there was a sharp increase in total sugar in the varieties that had enough normal tubers left to serve as samples. In the Katahdin and Sebago varieties this increase was largely due to the greater accumulation of sucrose, whereas in the Dakota Red tubers the increases in reducing sugar and in sucrose were nearly equal. By 16 weeks there was only a slight further increase in total sugar in the Sebago and Dakota Red varieties as compared with that after 10 weeks' storage. However, during the interim the relation of reducing sugar to sucrose had changed in that there was an increase in the former and a nearly equal decrease in the latter. Neither the Katahdin nor the Chippewa was sampled after 16 weeks because of decay.

No sugar analyses were made on the Maine-grown potatoes before they went into storage. The sugar content found after 8 weeks is shown in table 2. In 50° F. storage the sugar content of Katahdin and Bliss Triumph varieties was somewhat greater than at 60°. In the other two varieties there was an insignificant difference between

those at 50° and 60°. In all cases the total-sugar values in potatoes held at 50° and 60° amounted to less than 1 per cent. In 40° storage there was a distinct gain in total sugar, which varied from 1.1 to 1.5 per cent. In the tubers from 32° storage there was a sharp increase in total sugar but this was not quite so high as in the Maryland-grown potatoes, caused perhaps by the fact that the Maine potatoes were sampled after 8 weeks, whereas the Maryland lots were sampled after 10 weeks at the low temperature.

The foregoing results show that in the potatoes studied the total sugar content at 50° and 60° F. storage remained so low as to be practically negligible, but at 40° the total amount was 1 per cent or slightly over; whereas the reducing-sugar content was in all instances, except one, somewhat over 0.50 per cent which is considered about the limit above which discoloration or scorching will occur when drying or dehydrated. In 32° storage the total-sugar content built up to a range of 5 to 7 per cent, with the reducing sugar amounting to approximately 2 to 3 per cent. These potatoes seemed quite watery when cut and the raw flesh had a distinctly sweet taste.

In the "cured" lots, as noted in table 1, described as having been left at 60° F. for three weeks before being stored at 40° and 32° F., the total sugar remained practically the same in the Katahdin variety after 10 weeks at 40° and 32° as in those stored directly after digging; but after 16 weeks there was a gain of 0.6 per cent at 40° and of 1.0 per cent at 32° In the other varieties there was a gain in total sugar at both sampling periods. It is to be noted that although all the Chippewa potatoes stored at 32° directly after digging were affected by Mahogany browning, by the end of 10 weeks all those cured at 60° previous to being stored at 32° were sound after 10 weeks. After 16 weeks, however, these also had become affected. In all varieties excepting the Chippewa the reducing sugar was 0.2 to 0.7 per cent less in the cured lots at 40° than in those stored without curing, whereas the sucrose content remained practically the same or increased. After 16 weeks' storage at 40° the reducing sugar was slightly higher in the cured lots of both Katahdin and Chippewa potatoes that had been cured, and lower in the Sebago. In the Dakota Red this sugar was the same in both cured and uncured lots. In no case was the difference over 0.4 per cent.

In examining the results in 32° storage it will be seen that in the Katahdin variety there was practically no difference in the sugar content between the cured and uncured lots. In the Sebago variety there was a somewhat greater amount of both reducing sugar and

sucrose in the cured lots at the first sampling, but after 16 weeks there was little difference between cured and uncured potatoes, both having increased in sucrose and reducing sugar. In the Dakota Red variety, after 10 weeks, the cured lot had less reducing sugar and more sucrose, whereas after 16 weeks the sucrose had increased and the reducing sugar remained almost the same. It appears that the effects of the 3 weeks' curing at 60° previous to storage at 40° and 32° were somewhat inconsistent and probably indicate no great significance. Denny and Thornton (2) reported that several varieties of potatoes when held at approximately 70° F. for different periods of time before going into storage at 41°, showed increasingly less accumulation of reducing sugar as the storage date was delayed than when put directly into storage. The results of the present investigation confirm Denny and Thornton's (2) results insofar as delayed storage in 40° is concerned, but not for 32°. However, the difference in reducing sugar at 40° was small in most cases, and as will be seen later the differences in table quality of the dehydrated products were negligible.

Dehydration and Cooking Tests

Approximately one-half bushel samples of each lot were used for the dehydration tests. The material was prepared by a standardized procedure which was briefly as follows: Each lot was lye-peeled by immersion in a 10 to 12 per cent solution of caustic soda at 185° F. for 8 to 10 minutes, drained, washed in cold water, hand trimmed to remove all blemishes and remnants of stems and buds not removed by the lye, and then put through a mechanical slicer which cut the tubers into Julienne strips $\frac{3}{8}'' \times \frac{3}{8}''$ and about 2″ long. The strips were spread in a uniform layer on wire-bottom trays and blanched or precooked in live steam for 5 minutes. Between the operation of peeling, trimming, and blanching, the material was kept constantly submerged in a cold 2 per cent salt solution. After blanching, the material was put immediately into a steam-heated laboratory-type dehydrator. Drying was by parallel current flow with partial recirculation of the air. The fresh material entered the hot end of the drier where the temperature was from 165° to 175°. This was gradually reduced as the drying progressed, to a finishing temperature of 145° to 150°. The relative humidity at the hot end of the drier was 10 to 14 per cent and rose to 25 to 30 at the finishing end. When removed from the drier the finished material had a moisture content of about 7 per cent. When dehydration was complete, representative samples of each lot were stored in quart fruit jars at 50° for about 3 months before being cooked and judged for quality.

TABLE 3. *Quality ratings of cooked dehydrated potatoes from Maryland-grown stock stored at different temperatures. A rating of 1 to 1.9 is excellent; of 6.6 and upwards, very poor.*

Variety	Storage Temperature of Raw Stock	After 10 Weeks' Storage				After 16 Weeks' Storage			
		Color	Texture	Flavor	General Desirability[1]	Color	Texture	Flavor	General Desirability[1]
Katahdin	° F.								
	60	2.3	3.0	2.7	2.7	—	—	—	—
	50	3.4	2.8	1.9	3.2	4.1	3.2	4.7	5.5
	40	4.6	3.7	2.9	4.0	5.3	3.2	3.7	5.0
	32	—	—	—	—	6.1	5.2	6.2	6.5
	40 Cured	3.9	3.2	4.1	4.5	5.2	4.3	3.9	4.7
	32 Cured	5.5	5.5	6.6	6.2	7.0	7.0	8.2	8.0
Sebago	60	3.0	3.3	2.9	3.2	—	—	—	—
	50	4.1	3.3	2.6	2.9	4.0	2.7	3.1	3.7
	40	5.0	3.0	3.4	3.3	4.3	3.7	3.2	4.2
	32	5.9	5.3	6.2	5.8	6.1	4.7	6.1	6.5
	40 Cured	2.8	3.5	3.6	3.2	3.3	3.8	2.9	4.0
	32 Cured	5.4	5.8	7.0	7.5	7.4	5.5	6.0	7.3
Chippewa	60	2.5	2.8	3.0	2.7	—	—	—	—
	50	3.0	2.8	3.0	2.8	3.0	3.2	3.0	2.7
	40	4.1	3.3	2.9	3.5	4.1	3.5	3.2	3.9
	32	—	—	—	—	—	—	—	—
	40 Cured	4.1	3.0	2.6	3.4	3.5	3.0	3.0	3.0
	32 Cured	6.5	5.2	6.6	7.0	5.0	6.3	7.5	8.0
Dakota Red	60	2.6	2.2	3.5	2.7	—	—	—	—
	50	2.9	3.0	4.1	3.7	2.9	2.2	5.2	3.8
	40	4.6	3.0	4.4	3.5	3.0	3.0	3.4	3.6
	32	4.4	4.3	6.0	4.5	5.7	4.5	6.2	5.5
	40 Cured	3.0	2.7	4.2	3.2	2.7	3.0	3.7	3.3
	32 Cured	5.3	5.3	6.4	5.2	6.2	4.7	7.7	6.5

[1]General desirability is approximately a weighted average of color, texture, and flavor, taking into especial consideration the least desirable of these.

The general color of all lots of the dry material was compared with color charts in the Maerz and Paul (4) manual and the results were recorded. The details of these color values will be given in a later paper. In general the amount of reddish brown color in the strips of various lots increased as the temperature of the raw stock in previous storage approached 32°. In practically all varieties the most attractive color was found in the 50° or 60° storage lots. There usually was some grey present in the color of all except the 32° lots. In the 40° lots there appeared to be the least amount of grey. Here the general color was yellowish medium brown, whereas in the 50° and 60° lots the color of the best lots usually could be described as light yellowish with some grey overcast. In general the Maryland-grown potatoes were somewhat lighter in color than those grown in Maine. Maryland-grown varieties arranged in the order of decreasing attractiveness of appearance of the dried material were Chippewa, Dakota Red, Sebago, Katahdin; while in Maine-grown varieties they were Chippewa, Sebago, Katahdin, Bliss Triumph. The Bliss Triumph was by far the least attractive of all the lots.

Cooking tests were made on 75 gm. samples of each lot. These were soaked overnight in 225 ml. of water and then cooked for 30 minutes in a steam retort at atmospheric pressure. No salt or other seasoning was added since the presence of seasoning makes it more difficult to detect small differences in flavor. The color of the cooked products was determined by comparing with Maerz and Paul (4), and recorded in the same way as with the uncooked strips, after which various samples were scored separately for color, texture, flavor, and general desirability by a panel of 4 judges. During the scoring the samples were identified only by number.

The average results of the scoring are arranged in detail in tables 3 and 4. Scoring was on a numerical basis in which 1 to 1.9 was equivalent to excellent, 2 to 2.5 very good, 2.6 to 3.5 good, 3.6 to 5 fair, 5 to 6.5 poor, and 6.5 plus very poor. These results are summarized in tables 5 and 6, where descriptive terms only are used.

Tables 3 and 5 show the detailed ratings and general culinary quality of the dehydrated products made from Maryland-grown potatoes after 10 and 16 weeks of storage. The lowest numerical rating and the highest table quality were usually found where potatoes were served at 50° and 60° F. There was usually a progressive loss in general desirability as shown by the numerical ratings, as the storage temperature decreased, but in table 5 where the ratings are bracketed into groups under the descriptive terms good, fair, poor, etc., a grade

[1]General desirability is approximately a weighted average of color, texture, and flavor, taking into especial consideration the least desirable of these.

TABLE 4. *Quality ratings of cooked dehydrated potatoes from Maine-grown stock stored at different temperatures. Ratings as in table 3.*

Variety	Storage Temperature of Raw Stock	After 8 Weeks' Storage				After 12 Weeks' Storage			
		Color	Texture	Flavor	General Desirability	Color	Texture	Flavor	General Desirability
	° F.								
Katahdin	60	4.8	2.8	3.1	4.2	4.4	3.2	3.5	4.2
	50	4.5	3.0	3.5	4.5	4.4	2.8	4.1	4.2
	40	5.5	3.7	4.1	5.2	4.6	3.5	3.7	4.5
	32	6.7	4.7	7.1	7.7	6.6	6.3	6.4	8.6
Sebago	60	—	—	—	—	1.6	1.8	1.6	1.5
	50	4.2	2.8	3.9	4.5	3.0	2.7	2.7	2.5
	40	5.2	3.8	2.9	4.5	5.1	4.0	3.1	4.2
	32	6.4	4.7	6.1	7.0	8.9	6.0	7.1	8.5
Chippewa	60	—	—	—	—	2.5	3.5	3.0	3.0
	50	3.0	3.0	3.5	4.5	4.4	3.2	3.6	4.2
	40	3.6	3.0	3.5	3.5	4.4	3.2	3.4	3.7
	32	—	—	—	—	—	—	—	—
Bliss Triumph	60	—	—	—	—	5.2	3.5	3.9	4.2
	50	4.7	2.7	2.9	4.2	5.0	3.5	3.6	4.7
	40	5.6	3.2	3.9	4.7	5.4	3.7	3.9	3.7
	32	—	—	—	—	8.7	6.3	7.5	9.0

TABLE 5. *Table quality of Maryland-grown potatoes dehydrated after storage at different temperatures.*

Variety	Storage Temperatures of Raw Stock											
	After 10 Weeks' Storage						After 16 Weeks' Storage					
	60° F.	50° F.	40° F.	32° F.	40° F. Cured	32° F. Cured	60° F.	50° F.	40° F.	32° F.	40° F. Cured	32° F. Cured
Katahdin	Good	Good	Fair	—	Fair	Poor	—	Poor	Fair	Poor	Fair	Very poor
Sebago	Good	Good	Good	Poor	Good	Very poor	—	Fair	Fair	Poor	Fair	Very poor
Chippewa	Good	Good	Good	—	Good	Very poor	—	Good	Fair	—	Good	Very poor
Dakota Red	Good	Fair	Good	Fair	Good	Poor	—	Fair	Fair	Poor	Good	Poor

TABLE 6. *Table quality of Maine-grown potatoes dehydrated after storage at different temperatures.*

Variety	Storage Temperatures of Raw Stock							
	After 8 Weeks' Storage				After 12 Weeks' Storage			
	60° F.	50° F.	40° F.	32° F.	60° F.	50° F.	40° F.	32° F.
Katahdin	Fair	Fair	Poor	Very poor	Fair	Fair	Fair	Very poor
Sebago	—	Fair	Fair	Very poor	Exellent	Very good	Fair	Very poor
Chippewa	—	Fair	Good	—	Good	Fair	Fair	—
Bliss Triumph	—	Fair	—	—	Fair	Fair	Fair	Very poor

of good was given to all varieties except the Katahdin even from 40° after 10 weeks' storage. After 16 weeks' storage all of the tubers were badly sprouted in 60° and were discarded. Only the Chippewa variety was rated as good in 50° and all varieties were fair in 40°; therefore it is apparent that there was a general loss in quality between 10 weeks and 16 weeks in storage. Curing previous to storage apparently caused no consistent improvement in quality.

Tables 2 and 4 show that, in general, the Maine-grown potatoes also decreased in quality as the storage temperature was lowered. After 8 weeks' storage the quality of these potatoes seemed to be lower than that of the Maryland-grown potatoes stored 10 weeks. However, after 12 weeks' storage the Maine-grown Sebago lots from 60° and 50° F. were graded higher than any of the other lots under any condition. The Maine-grown potatoes stored at 32° were all graded very poor, receiving a lower rating than those from Maryland. None of the potatoes graded as poor would be considered acceptable.

Summary

Potatoes of several varieties were stored at 60°, 50°, 40°, and 32° F. When removed from storage the sugar content of those from the two highest temperatures was low, from 40° it was intermediate, and from 32° excessively high. When these potatoes were dehydrated the highest quality was found in those from 60° and 50° storage where the sugar content was low. In those from 40° storage the quality was mostly good to fair, and from 32° the quality was invariably poor to very poor. These last were sweet, soggy, and badly discolored or scorched due to caramelization of much of the excess sugar.

In conclusion it was shown that under the conditions of these investigations there was a definite correlation between the quality of dehydrated potatoes and the previous storage temperature of the raw stock. In general, in the early part of the storage season the best quality of dehydrated material was derived from potatoes stored at either 60° or 50° F. Later on, however, sprouting occurred at 60°, being extensive enough in the Maryland-grown potatoes to render them unfit for use. In 50° storage sprouting was barely apparent at the first sampling but after 16 weeks' storage the quality had in general decreased. In potatoes stored at 40° little change in quality occurred.

It is therefore recommended that a storage temperature of 60° or 50° F. is suitable or even preferable for potato stock to be used within 8 or 10 weeks. Stock to be held much longer than this should be stored at about 40°.

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OREGON "GUINEA PIGS" THE FAR WEST'S PROPOSED NEW SEED POTATO GRADES

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In recent years the tendency for the western potato industry to become centralized in a few favorable spots has had a big effect upon seed buying. In an area where nearly every farmer is a potato grower, such as Kern County, California, or Klamath County, Oregon, the merits of various lots of seed are warmly debated. If one grower's seed is uniformly good, even if he lives in a distant state, his product is sought, often very keenly, and buyers come to him offering to take his entire crop—just as it comes from the field—with nothing thrown out but rots.

In most states the grades for certified seed were set years ago when the whole idea was new and when it had to fight to make its way. Much of the seed was sold in far away markets to people who never heard of the grower, and they bought potato seed just as they bought apples—or picked wives—largely upon appearance.

The new tendency, to buy upon performance with absolute disregard for appearance, therefore has not fitted the old grades. The buying habits have a basis in scientific fact in that so far as the writers know, no trial has ever shown that No. 2's and culls from a good lot of certified seed produce crops in any way inferior to those produced from the No. 1's from the same field.

Before OPA, the field run buying had no serious drawbacks except that in most states such potatoes could not be tagged as certified seed,

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and, therefore, part of the very best seed in the west moved untagged. With the advent of OPA ceilings, these field run sales hit a snag. The rules are that the tag constitutes the difference between commercial stock and seed. Practically every western seed sale for three years has been at the ceiling. Therefore, even if a grower sold his potatoes as "field run" he was forced to sort them to meet tag requirements and part of his crop, for which buyers were willing to pay a substantial premium, could not be tagged at all. On this part he could collect no premium if he stayed within the law—in fact he had to sell them at a discount under U. S. No. 1's to a buyer who was willing and anxious to pay more.

This matter has been under discussion by western certification authorities for some time, but it was brought to a head at the Western States Seed Certification meeting in Corvallis, Oregon, on the 21st, 22d, and 23d of June. Those present at this meeting agreed to take back to their home states, for further discussion, a plan to revise grades for certified seed to take care of "field run" sales and other special sorts. It was felt that if several of the western states could adopt the same grades, confusion would be avoided in cases of sales across state lines. The Oregon folks agreed to be the guinea pig—to test these grades on the 1945 crop so that if they worked all right, the other states could use them for 1946.

Here are the grades agreed upon by the representatives of six states at the Corvallis meeting:

1. *Blue Tag Seed*

   (a) Blue Tag U. S. No. 1 shall consist of potatoes of good varietal type from 1-7/8 inches in diameter to 12 ounces in weight, and shall conform to all the standards for U. S. No. 1 potatoes.

   (b) Blue Tag A shall consist of potatoes which meet all the requirements of U. S. No. 1 grade for quality and condition except that sunburn (not to exceed 15 per cent of the skin area darkly greened), lightburn, insect injury (not serious damage) and hollow heart (not affecting seed value) may be included in this grade.

   In order to allow for variations other than size incident to proper grading and handling, not more than a total of 15 per cent of the potatoes in any container may be below the requirements of this grade, but not more than 6 per cent may be seriously damaged by cuts, bruises, or badly misshapen potatoes but not to exceed one-sixth of this amount, or 1 per cent, shall be allowed for potatoes affected by soft rot or wet

breakdown and 2 per cent by late blight, and no fresh cuts will be allowed.

Each potato shall be not less than 1 ounce and not over 14 ounces in weight. Not more than 1 per cent of the potatoes in this grade shall be below the specified minimum size and not more than 5 per cent shall be above the specified maximum size, but no potatoes over 18 ounces in weight will be allowed.

(c) Blue Tag Single Drop shall consist of potatoes between 1-1/2 and 2 inches in diameter or between 1 and 3 ounces in weight and shall otherwise conform to all the grade standards specified for Blue Tag A grade.

Not more than 1 per cent may be below the minimum size and not more than 5 per cent may be above the maximum size.

2. *Red Tag Seed*

(a) *Red Tag FIELD RUN* shall consist of potatoes in the same proportion of U. S. No. 1's, No. 2's and culls as they came from the field except that fresh cuts, damage from bruises, badly misshapen potatoes, serious damage from dirt, or tubers with more than one knob removed, above a 6 per cent tolerance, shall not be allowed. Of this amount, not to exceed 1 per cent shall be allowed for potatoes affected by soft rot or wet breakdown and 2 per cent by late blight.

Not more than 1 per cent by weight of the potatoes in this grade shall be less than 1 ounce in weight.

(b) *Red Tag SORT OUTS* shall consist of No. 2's and certain other potatoes that are defects of No. 2's, but the following defects shall not be allowed in this grade:

1. Badly misshapen potatoes.
2. Serious damage from insect or rodent injury.
3. Serious damage from mechanical injury except that potatoes under 6 ounces in weight may have one end clipped provided not more than one-fourth of the potato is cut away.
4. Serious damage from dirt.
5. Fresh cuts.

A 6 per cent tolerance for the foregoing defects shall be allowed, but of this amount, not to exceed 1 per cent shall be allowed for potatoes affected by soft rot or wet breakdown and 2 per cent by late blight.

Not more than 1 per cent by weight of the potatoes in grade shall be less than 1 ounce in weight.

The above 5 grades provide for nearly every selling contingency. If a grower sold U. S. 1's, he could then offer the U. S. 2's, green ends, hollow heart, etc., as Red Tag Sort Outs. If he sold Blue Tag A, and still had some U. S. 2's left, these again could be offered as Red Tag Sort Outs. If he sold Red Tag Field Run, he would tag and move practically his entire crop.

The writers will welcome comments from certification authorities in states not represented at the Corvallis meeting and from growers or others interested in seed certification. We believe that the time has come when seed should be divorced from table stock grades so far as practicable.

SECTIONAL NOTES

CALIFORNIA

At the present time we are completing digging of approximately 3,000 acres of potatoes in the mountains of which probably ⅓ to ½ will be used as seed in 1946. There will be a small acreage harvested in the floor of the valley which was planted in August and early September. This acreage will probably be harvested during the latter part of November and the early part of December. As far as the supply of seed for 1946 is concerned all indications are that ample seed will be available for the acreage to be planted.

The general feeling among potato growers in Kern County, as nearly as we have been able to determine by inquiry, is that they would like to see an acreage of approximately 44,000 to 46,000 acres in the floor of the valley for harvest between the 1st of April and the 15th of July, 1946. The acreage for the same area in 1945 was approximately 56,000.

By the time this issue of your Journal is published, the government's goal will probably be published. Many growers in this county fear that the goal will probably be very drastic in Kern County. Some growers have indicated that if the goal is too drastic in its cut under the acreage of 1945, that they will not attempt to comply. However, this remains to be seen after the goal has been established. (Oct. 3)—M. A. LINDSAY.

INDIANA

Our potato harvest is very much under way and I presume that the harvest will be completed before the month is over. We find a good movement of potatoes—Indiana stock U. S. No. 1, washed or

brushed, that are selling readily and the growers are getting a jump on the big potato movement from the North and the Northwest. We have been most fortunate in planting a limited acreage in this state and the acreage in the hands of growers who have given a study of this business. So far there have been no reports about feeding any potatoes to livestock or other disposition other than to the regular channels. Outside of some few No. 2 size potatoes that have been saved, most of our growers are purchasing certified potato seed from states that do certification work and have the varieties in question. We have found during this past year, however, that the Sequoia and the Sebago potatoes are still outstanding producers and scattering reports from all parts of the state list the Sequoia as being the "tops." This variety seems to be well adapted to the mineral soils of central and southern Indiana making a nice uniform tuber in size, and the yields are somewhat less than will be found upon the muck. From reports received concerning the Sequoia, this variety yields more than 400 bushels per acre whereas the Irish Cobbler yields between 60 and 75 bushels in poor years to 125 and 150 in more favorable years. It is estimated that the average yield per acre in Indiana this year will be approximately 155 bushels. (Sept. 28)—W. B. WARD.

MINNESOTA

Owing to the fact that we had a delayed planting season, field inspections were completed somewhat later than is usually the case. Approximately 17,700 acres of potatoes have met the field inspection requirements. This is considerably less than the acreage passed for certification in 1944. In general, growing conditions were favorable for the production of a fine quality crop and harvesting is in full swing at the present moment. Indications are that yields are going to be somewhat better than last year when considerable loss was sustained by some growers because of water logging. Until the 20th of September very little digging had taken place in the Red River Valley area because of intermittent showers, but the weather during the past three weeks has been quite favorable for harvesting operations, and it appears that the crop will be harvested unless a hard freeze occurs during the present week.

Inspectors have been collecting and assembling samples for our official seed source testing plots in the south during the past four weeks. Plans are being made to include additional areas in the seed-consuming areas for this type of work.

During the past three or four years, a considerable number of

modern track-side storages have been built and more are being built this year, some being equipped with washing equipment. Many of the larger certified seed potato growers are building such warehouses which facilitate the loading of cars during the cold winter months. (Oct. 9)—A. G. TOLAAS.

NEBRASKA

Harvesting of the main crop got into full swing on the first of October, after a week of cold and wet weather. Digging would have been under way a week earlier, had it not been for the fact that from four to six inches of snow blanketed most of western Nebraska. The snowfall was a blessing in disguise, however, as temperatures dropped as low as 26° during that time, and many potatoes would have been frozen if the ground had been bare.

Because of varying conditions at the end of the season, the range of yields on both dry and irrigated fields varied greatly. Dry land fields have in all cases yielded at least 100 bushels per acre,—with quite a few running as high as 200, and an exceptional one running as high as 300. Irrigated fields range from 200 to more than 400 bushels per acre. Not enough yields have been reported to get an average, but these should be approximately midway between the extremes noted.

The quality of practically our entire crop is very good. Our potatoes are apparently smooth and more free from scab than usual. Damage, from flea beetles which have become a serious pest in many territories, is negligible this season. Because of late rains, the color of the Nebraska Triumphs will be good in practically all cases. This has become a selling point, and is responsible for good table stock prices at this time.

U. S. No. 1 Grade is being sold at $2.50 per cwt. f.o.b. shipping points,—considerably higher than was thought possible not more than two weeks ago. Before digging began dealers and growers alike despaired of getting the support price of $2.15 per cwt. for December delivery.

The CCC has been active in this territory and the Government is offering loans on potatoes on the following basis: $1.26 per cwt. for the potatoes grading U. S. 1, as soon as they are placed in acceptable storage places. U. S. No. 2, inch and seven-eighths minimum, or B-Size, U. S. 1 quality, at 40 cents per cwt. This program calls for the Government to buy the potatoes sometime after December, until the first of March at the support price of $2.15 per cwt. for U. S. No. 1 quality. These potatoes of course, will be sacked, graded and loaded on board cars.

Not much can be said about the prospects for planting next season,—however, it is expected that there will be a large demand for Foundation seed potatoes to plant certified seed a year from now. The price of certified seed is not established at present, but the indications are that it will be about $2.50 per cwt. as soon as selling begins. (Oct. 15)—MARX KOEHNKE.

NEW JERSEY

One of New Jersey's largest potato crops is now practically harvested. Our growers have experienced one of the most trying seasons on record. Starting with adverse planting conditions in April the growers were then prevented from properly cultivating or spraying their crop in midseason because of continuous rains. Then, in July when prices were at ceiling and the demand strong, growers were again unable to harvest their crop because of excessive rains. This environmental factor has been the cause of our worst late blight epidemic in 30 years. Tuber rot caused by excessive rains, also the late blight have resulted in the loss of our normal markets. When weather conditions did permit full scale harvesting, prices had declined to support levels and the market was not able to absorb the supply. This resulted in a very slow movement of the crop.

The CCC program to support prices was inadequate and growers were forced to sell at prices below support in order to insure getting their crop moved before freezing weather. This further demoralized the market with the results that many growers did not receive the cost of production for some of their acreage.

In order to insure the harvest of all potatoes before freezing weather and to continue support of the price, the Government instituted, a field storage program, and many growers have therefore sold their potatoes to the government and piled large quantities of them in the fields where they are covered with straw or hay. It is the intention of the government to sell many of these potatoes to producers of industrial alcohol. To date the Government has purchased approximately 3,200 cars of potatoes in their effort to support prices. Some of these were given to hospitals and other such institutions while many others were given to dairymen for feeding purposes.

It has been difficult to obtain labor and manage them due to the independent attitude and in many instances their refusal to work more than a few days a week. Labor charges have also been excessive, many growers paying $1.00 and more per hour for loading and grading operations. Contractors have been charging from 25 cents to 35 cents per cwt. to have their potatoes picked and graded.

Growers must plan to regulate the acreage planted to potatoes according to government request if they are to expect government support of prices. Undoubtedly there will be a request for a reduced acreage in most sections of the country and plans should be made accordingly. (Oct. 19)—J. C. CAMPBELL.

NEW YORK

The October estimate of the 1945 New York potato crop remained at approximately 30 million bushels, the same approximate production published for September. The weather upstate was favorable for the continued development of those potatoes which were well sprayed and growing. The rainfall was generally very much above normal and not only interfered with harvesting operations but also probably increased the damage from blight rot already evident in many fields. The first killing frost occurred on the night of the 30th of September. This terminated growth in many fields, which needed more time to develop marketable-size tubers.

All indications point toward an excellent crop in Northern New York and of course the Long Island crop has already been reported as big. The average yield in Western New York will be considerably below that of 1944. This is true of both muck and upland fields. Digging is in full swing in Steuben County where yields are averaging from 150 to 250 bushels. This is at least 50 bushels below the average of last year. Fields in Western New York that were not well sprayed are showing some blight rot. In a few areas, the low temperature on the 30th of September was sufficient to injure exposed tubers,—especially Katahdins which set shallow and were uncovered by recent heavy rains. According to the present estimated average yield, New York state will be 161 bushels to the acre,—the highest on record. This record will be due to the large crop on Long Island where the average is estimated to be 220 bushels as against a low of 105 bushels for upstate.

The annual convention and show of the Empire State Potato Club is scheduled at Hotel Statler, Buffalo, for the 3rd and 4th of January, 1946. The theme of the convention, which will be a joint affair with the New York State Vegetable Growers' Association, is "Production for Victory." Growers are asked to submit competitive potato sample exhibits of 15 tubers each in approximately 15 variety classes. A feature of the potato program will be a half-day round-table discussion of the future of the potato industry in New York. Buffalo is an easy place to reach in the winter and growers and station workers

in neighboring states and Canada are cordially invited to attend. (Oct. 15).—E. V. HARDENBURG.

LONG ISLAND

The Long Island potato crop is nearly all harvested, and, for the most part, marketed.

There are less potatoes stored than usual. The Long Island acreage was about seventy thousand acres,—varying between fifty-five and sixty thousand acres in Suffolk,—the balance being in Nassau County. In general, the crop was very good.

It is estimated that 60 per cent of the total production of New York State was grown on Long Island this season.

Lack of confidence in the Government's support program is the cause of the desire of the growers to sell as rapidly as the crop is harvested.

The writer has made a recent trip by auto through Northern New York, Aroostook County, Maine, and Prince Edward Island. There is every indication that there will be an ample supply of Cobbler, Green Mountain and Katahdin certified seed, if the weather is such as to permit the complete harvesting of the crop. The Cobbler crop was very materially reduced in both Maine and Prince Edward Island by drought, but a very large increase in the acreage of Cobblers in Prince Edward Island will make up the shortage to a great extent. The increased plantings of Katahdins will lessen the demand for Cobblers.

The tubers will be smaller than usual, therefore the seed will go farther. (Oct. 10)—H. R. TALMADGE.

OHIO

The early crop of potatoes has been harvested and 90 per cent marketed. The rains during the past three weeks have interfered with the late harvest and about one-third of the late crop is still in the ground. Two weeks of dry weather are needed to complete late harvest.

Growers do not fully realize the necessary adjustments which will follow the discontinuance of Government support. However in Ohio during the past three years the acreage has dropped from 120,000 to approximately 70,000. Ohio growers, in general, feel that this acreage reduction should take care of any adjustments in this state.

There is a tendency in a state like Ohio for the acreage to increase during low-price years and to decrease during high-price ones. More growers produce potatoes when general farm prices are low; probably in an attempt to be more self-sufficient. These small acreages produce

many potatoes,—during years favorable for the growth of the crop,—which cause a local marketing problem. (Oct. 13)—EARL B. TUSSING.

VERMONT

Confirming earlier predictions, the general yield of potatoes in Vermont is very light. A great many of the small, non-commercial fields died off prematurely in early August, leaving a size "B" crop. In some cases they were scarcely worth digging. The cause of this early dying off seems to have been a combination of early blight and adverse weather conditions. Starting out during an exceedingly wet period, the plants apparently could not survive the sudden change to extreme heat followed by a short period of dryness. In the case of the large commercial and seed fields planted on generally better lands and given better cultural care, the growth continued more normally, and the yields are being reported as varying from "fair" down to 125 to 150 bushels per acre.

There has been comparatively little late blight, but there was a considerably larger amount of blackleg, and an abundance of virus diseases,—mainly leafroll.

The acreage certified for seed is smaller than has been the case for many years,—about 260 acres from approximately 550 entered. A tremendous spread of leafroll during the 1944 season was carried over in much of the seed used and caused the heaviest part of the rejections.—particularly in Green Mountains. About 100 acres have been given War Approved status. (Oct. 12)—HAROLD L. BAILEY.

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TRANSMISSION AND SPREAD OF LATE BLIGHT IN SEED POTATOES

A. H. EDDINS

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An outbreak of late blight of potatoes, *Phytophthora infestans* (Mont.) D. By., occurred in 1937 in the Hastings Section, Florida, where it caused a seed piece rot and reduced stands 10 to 90 per cent in many fields, as shown in Fig. 1, A and B. An unusual amount of

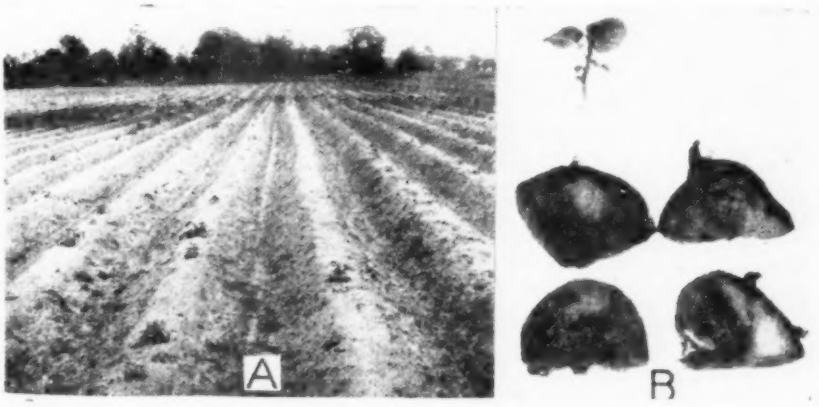

FIG. 1.—Section of a potato field in which 90 per cent of the seed pieces were destroyed by late blight, A, and decaying pieces found in this field 3 weeks after planting, B.

the disease was present in seed potatoes used for planting that year, some bags from Maine containing as much as 10 per cent infected tubers

on arrival in Florida. Ordinarily, Maine-grown seed potatoes are reasonably free from late blight, with the number of infected tubers seldom exceeding 2 in each 100-pound bag and with most bags free from blight.

Climatic and soil conditions were ideal for rapid germination and early growth of potatoes during January 1937 and when some fields were inspected 10 days after planting, many seed pieces were found affected with blight, (Fig. 2), and many sprouts were blackened

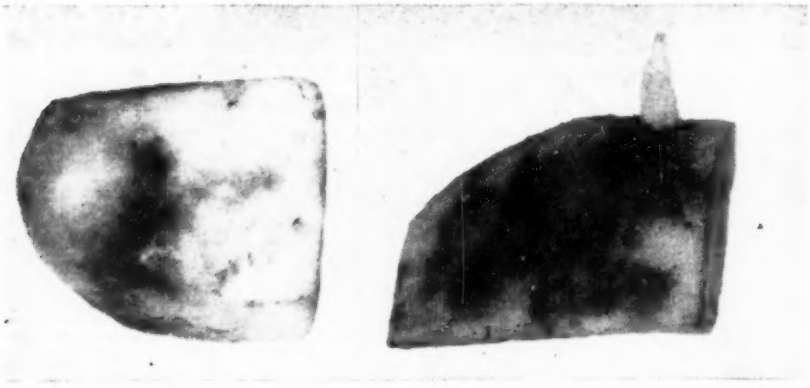

FIG. 2.—Seed pieces 10 days after planting with sprouts killed or stunted and cortex removed to show discoloration of flesh caused by *Phytophthora infestans*.

by the disease on emergence from the soil. In some fields, the fungus produced spores on the stems of young plants 24 days after the seed had been planted.

Temperatures and rainfall during December 1936 and January 1937, shown in table 1, were favorable for the development of blight, and it was not controlled satisfactorily by dusting the plants with copper-lime dust at intervals of a week to ten days, beginning when the plants marked the row and ending a few days before digging (2). The disease caused the greatest reductions in yield where it destroyed the seed and reduced stands by 20 per cent or more. The loss for the entire section, comprising approximately 15,000 acres of potatoes, was estimated at 15 per cent.

SPREAD OF LATE BLIGHT IN SEED POTATO BAGS

Bonde and Schultz (1) stated recently that much of the late blight tuber rot which develops in storage houses in Maine is due to infection that occurs while the crops are being harvested. Freshly-dug tubers become inoculated with the fungus spores from green or partially dead stalks and leaves and the disease appears in the potatoes one

TABLE I. *Weather data for December and January and loss caused by late blight from* 1936 *to* 1945, *inclusive.**

Year	December			January			Loss from Late Blight (Per cent)
	Number Rainy Days	Total Rainfall (Inches)	Mean Temp. °F.	Number Rainy Days	Total Rainfall (Inches)	Mean Temp. °F.	
1936	13	2.81	59.6	—**	—	—	4
1937	5	0.64	55.6	12	2.60	68.1	15
1938	4	0.76	55.8	9	1.17	56.5	2
1939	5	2.25	56.8	5	1.59	58.2	2
1940	11	7.49	63.0	7	1.61	47.4	Trace
1941	9	4.58	61.8	11	3.18	56.2	4
1942	11	4.07	61.4	6	1.30	55.1	1
1943	5	1.17	58.6	4	1.62	59.4	Trace
1944	6	0.68	55.6	7	3.16	56.7	15
1945	—	—	—	7	3.93	57.6	0
Average	7.7	2.72	58.7	7.6	2.24	57.2	4.8

*Data on rainfall and temperature obtained from U. S. Weather Bureau.
**Not given because potatoes were not exposed.

or more weeks after they are placed in storage or are shipped to market. These workers proved that the amount of tuber rot might be greatly reduced by delaying digging until the potato tops matured and died or were killed by frost or with an herbicide.

Melhus (4) proved that the late blight fungus, *Phytophthora infestans,* hibernates in tubers of Irish potatoes, and Godfrey (3) reported that an outbreak of the disease in the Lower Rio Grande Valley, Texas apparently originated in fields planted with blight-infected seed potatoes. In 1941, tubers became infected with blight in Florida in seed potato bags containing tubers affected with the disease. This was demonstrated on a farm near Hastings where approximately 100 bags of potatoes containing 1 to 2 per cent late-blight-infected tubers per bag were stacked in a barnyard on the 18th of December. When cut for planting one month later, approximately 30 per cent of the tubers were found to be affected with blight, and the increase in the disease was attributed to infection from spores produced on diseased tubers and brought in contact with healthy tubers by rain water. The bags and tubers were wet by 7.62 inches of rain which fell on 12 of the 30 days the potatoes were in the barnyard, thus ample moisture was present in the bags for several successive days and temperatures were favorable for spore production and germination and infection of healthy tubers, (table 1). Similar conditions also prevailed in 1937 when some lots of seed became severely infected with blight after their arrival in Florida. That year the disease destroyed 90 per cent of the seed pieces of one lot which was stored in 165-pound bags in an open lot for 30 days before planting and was wet by 2.81 inches of rainfall which fell on 13 of the 30 days.

A test was made in 1942 to study the spread of late blight in seed potato bags. Fifty lots of potatoes were used and each consisted of 23 pounds of healthy tubers and the proper weight of late-blight-infected ones to make up the percentages, 0.5 to 15.0, as is shown in table 2 The potatoes were placed in 50-pound jute bags and exposed to different conditions for 5 weeks.

There was no spread of late blight in the different lots held in the storeroom where they were kept dry, or outside where they were exposed to direct sunlight during the day, although the latter were wet by 1.90 inches of rainfall which fell on 9 days during the storage period. The greatest spread of the disease occurred in bags kept in shade on the north side of the storeroom where they were wet by 1.90 inches of rainfall and by water equivalent to 1 inch of rainfall applied on each of the first 4 days of the storage period. The second greatest spread occurred in bags held in the shade of the storeroom where they were

TABLE 2.—*Increase in late blight tuber infection in different lots of potatoes made up to contain different percentages of infected tubers and exposed to different conditions in jute bags from December 17, 1941, to January 23, 1942.*

Percentage Infected Tubers at Beginning	Percentage Increase in Late Blight Tuber Infection When Potatoes Were Stored				
	Inside Storeroom	Outside Exposed to Sun During Day		In Shade on North Side of Storeroom	
		Wet by 1.90 in. Rainfall	Wet by 1.90 in. Rainfall Plus 4 in. Water Applied First 4 Days	Wet by 1.90 in. Rainfall	Wet by 1.90 in. Rainfall Plus 4 in. Water Applied First 4 Days
Healthy	0.0	0.0	0.0	0.0	0.0
0.5	0.0	0.0	0.0	0.0	1.0
1.0	0.0	0.0	0.0	0.0	0.0
2.0	0.0	0.0	0.0	0.0	13.0
3.0	0.0	0.0	1.3	7.0	8.7
4.0	0.0	0.0	1.7	0.0	15.2
5.0	0.0	0.0	9.6	1.0	13.0
6.0	0.0	0.0	0.0	7.8	1.3
15.0	0.0	0.0	0.0	0.0	9.3
Apparently Healthy*	0.0	0.0	0.0	0.0	2.3

*Obtained from a field severely affected with late blight.

wet only by rains. There was also some increase in the disease in 3 lots exposed to the sun and wet by rains and 4 additional inches of water.

The disease did not develop in healthy lots free from blight-infected tubers and only 2.3 per cent of the apparently healthy tubers obtained from a field severely affected with the disease developed blight when kept in continuous shade of the storeroom for 5 weeks, and wet by 1.90 inches of rainfall and 4 additional inches of water.

The disease increased from 1 to 15.2 per cent in bags kept in continuous shade and wet by 1.90 inches of rainfall and 4 additional inches of water. The least increase in infection occurred in a bag containing 0.5 per cent infected tubers at the beginning of the test and conducted during the last 3 years substantiate results secured in 1942.

In 1942, whole tubers of the 10 lots stored in continuous shade and wet by rainfall plus 4 additional inches of water were planted and observations were made in the development of blight on the plants. Only a few of the infected tubers failed to germinate. However, plants originating from infected seed were noticeably smaller throughout the growing season and were less productive than those originating from healthy seed. The season was not favorable for development of blight and there was as much of the disease on plants grown from healthy seed as there was on those grown from diseased seed.

Discussion and Conclusions

Results of tests have shown that late blight spreads from diseased to healthy tubers in seed bags in Florida under certain conditions. The greatest increase in the disease occurred when potatoes were stored in the open where they remained wet for prolonged periods during rainy weather or when kept in continuous shade where they dried slowly after rains. There was no spread of the disease in bags kept dry, as there was not enough moisture on infected tubers to enable the fungus to grow and produce spores. The disease even failed to spread in some bags containing infected potatoes exposed to conditions favorable for blight development, probably because the fungus was no longer alive in the blighted tubers.

Twenty-five rainy days during the 2-month period of 1936-'37 favored development of late blight and much seed exposed to the weather in December became infected; and after it was planted, the fungus grew rapidly in seed pieces and produced spores on the sprouts and on the stems of young plants, (table 1).

Weather conditions were also conducive to development of the disease during December and January of the 1940-'41 period and some seed became infected after its arrival at Hastings. However, most of the infected seed rotted after it was planted and only a few plants originating from diseased seed developed blight during the early part of the growing season.

The 15 per cent loss caused by blight in 1944 was not caused by an early outbreak of the disease, but it appeared during an extremely wet period in late March and April when the rainfall totaled 12.86 inches and the disease spread from blighted plants in early-planted fields which were almost mature enough for digging.

It proved impossible to predict the occurrence of late blight in the field in Florida even when infected seed were planted. Most of the diseased seed usually rotted without sprouting or produced weak sprouts which soon died or formed small, low-yielding plants. Numerous

primary infections were observed in the field in 1937 and in 1941 and others were produced by planting infected seed pieces in flower pots in the greenhouse. However the data obtained are not sufficient to define conditions under which the disease originates from infected seed planted in the field.

Late-blight-infected tubers in seed potatoes are the primary source of the disease in Florida. If the seed are dug after the potato tops have matured and died or have been killed by frost or herbicides as recommended by Bonde and Schultz (1) and all infected tubers are thrown out before they are shipped to Florida, there should be little transmission and spread of late blight in seed potatoes, particularly if the tubers are kept dry from the time they are harvested until planted.

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THE USE OF TUBER SPECIFIC GRAVITY IN DETERMINING THE EFFECTIVENESS OF LEAFHOPPER INSECTICIDES

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The specific gravity of potato tubers has been used extensively in recent years as an index of eating quality. As such, it has been used to evaluate varieties and the effects of fertilizers and other cultural practices. This paper presents data relative to its use in the evaluation of the effectiveness of insecticides in the control of leafhoppers and to the associated effects on tuber quality.

Marshall *et al.* (5) have demonstrated that potato leafhoppers (*Empoasca fabae*) are especially effective in causing a reduction in

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the apparent photosynthesis of apple leaves. In their experiment, ten to fifteen leafhoppers per leaf, feeding for a period of two weeks, caused a reduction of 60 per cent. The leafhopper effect on the photosynthesis of leaves of most potato varieties might be expected to be even greater because of the additional factor of the reduction in functional leaf area due to hopperburn. In their variety experiments in 1937 and 1938, Allen and Rieman (1) measured this latter factor and reported Irish Cobbler as having 48.05 per cent and 72.18 per cent hopperburned leaf tissue respectively.

In light of these facts and in consideration of the physiological relationships involved, it would seem reasonable to assume that the extent of leafhopper injury on potatoes might be reflected in the concentration of starch accumulated in the tubers. The work of Mader and Mader (4) supports this assumption. They found that the tubers of Bordeaux-sprayed and unsprayed potatoes had an average starch content of 14.25 per cent and 12.78 per cent respectively. Since the specific gravity method affords a quick and practical way of estimating the starch content of potato tubers, it was used in the present study to check further into this relationship.

The experiment which we have reported was carried out on Irish Cobbler potatoes at the Cook County Experiment Station at Des Plaines, Illinois, in 1944. Its purpose was the evaluation of several new insecticides. The proportion of hopperburned leaf tissue was not determined. The loss of foliage, however, was very severe on the untreated and poor treatment plots. The rainfall was subnormal and is thought to have been largely responsible for the relatively low yields on plots where the leafhoppers were well controlled,

Applications of insecticides were made on the 15th and 24th of June and on the 6th and 20th of July. A crank duster and knapsack sprayer were used and the rates of application were higher than commonly recommended.

The method of determining the specific gravity was essentially the same as that reported by Haddock (3) except that .010 intervals were used between the specific gravity of the brines instead of .005. Thirty tubers from each plot were used in these determinations.

The results are presented in table 1. Each figure represents the average of three replications. The per cent of starch was calculated from Von Scheele's equation as reported by Blood and Prince (2). The pounds per acre of starch were obtained by multiplying the pounds of tubers per acre by the per cent of starch.

Under the conditions of this experiment, the control of leafhoppers

TABLE 1. *Potato leafhopper experiment, Cook County, Illinois, 1944.*

Treatment	Nymphs per Leaf 6/22	Nymphs per Leaf 6/30	Yield per Acre of Tubers over 1½ Inches, Bu.	Specific Gravity	Per cent Starch	Pounds of Starch per Acre
3 per cent DDT	4.3	0.1	115	1.076	13.0	895
DN5 and undiluted calcium arsenate	9.1	2.7	103	1.067	11.2	692
4-4-50 Bordeaux plus 2 lbs. calcium arsenate	16.2	4.3	98	1.067	11.2	657
20 per cent monohydrated copper sulphate 20 per cent calcium arsenate 60 per cent hydrated lime	12.0	2.5	98	1.068	11.4	672
4-4-50 Bordeaux	12.1	3.2	87	1.067	11.2	588
Dusting sulfur and 20 per cent calcium arsenate	17.8	3.4	81	1.069	11.6	563
0.15 per cent pyrethrins	20.5	7.4	72	1.069	11.6	502
Crop saver potato dust	15.7	9.6	66	1.065	10.8	431
14 per cent Lethane B-71 and 20 per cent calcium arsenate	11.2	5.6	65	1.065	10.8	426
0.5 per cent rotenone dust	14.2	17.0	56	1.060	9.8	356
20 per cent calcium arsenate	14.9	12.2	40	1.061	10.0	244
Untreated	17.5	31.6	18	1.056	9.0	103
Difference for significance (5 per cent)	6.7	6.2	27	0.006		201
Difference for high significance (1 per cent)	9.0	12.3	36	0.009		273

was associated with increases in both the yield and the per cent of starch in the tubers. The correlation coefficient between the nymph counts and the yields is —.95 and is highly significant. Between the nymph counts and the specific gravity of the tubers, which reflect the starch content, the coefficient is —.87 and is also highly significant. This suggests that the insecticides were more effective in keeping the leaves functioning normally than the yields alone would indicate and that the number of pounds of starch per acre, which reflects the magnitude of both the yield and the starch concentration in the tubers, might be a better criterion of their effectiveness. The difference in the relative effectiveness as indicated by these two criteria was marked. The DDT treatment, for instance, produced a yield six times as great as the check plot but nine times as much starch per acre.

In comparison of the DDT and DN5 treatments the choice of criteria becomes important from the standpoint of the statistical analysis of the data. Although the DDT treatment did not significantly reduce the nymph counts or increase the yields as compared with the DN5 treatment, it produced an amount of starch that was significantly greater. This discrepancy between the nymph counts and the pounds per acre of starch can be explained by the fact that the leaves of the DDT treated plants not only sustained less damage but also remained in good condition over a longer period of time. The nymph counts indicate only the potential damage whereas the number of pounds of starch per acre is a measure of the lack of damage over a period of time. If soil conditions had been more favorable, the amount of tuber growth might have kept pace with the greater amount of starch in the plots treated with DDT and the discrepancy between the yields and the pounds per acre of starch might have been less or non-existent.

Since high specific gravities are associated with more mealy and therefore more palatable potatoes, it is apparent that the use of insecticides resulted in better eating quality of the tubers. The degree by which the better treatments increased the quality was very noticeable when tubers from different plots were cooked. The increased starch content of the tubers also indicates a higher nutritional value.

Summary

The specific gravity of potato tubers was determined on samples taken from a leafhopper insecticide experiment. Treatments that resulted in tubers of the highest specific gravity and consequently, the highest starch content and best eating quality, were those having the lowest nymph populations and the highest yields. The pounds of starch produced per acre, obtained by multiplying the per cent of starch

in the tubers by the yields, was shown to be a better criterion of the effectiveness of the insecticides than the yields under the conditions of the experiment.

The ease with which specific gravity determinations can be made, and the value of the supplementary data obtained, make this criterion worth consideration in tests of insecticides used against leafhoppers on potatoes.

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EFFECT OF PLANTING DEPTH ON YIELD AND TUBER SET OF POTATOES[1]

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In Kern County, the largest and most important potato-producing area in California, the seed pieces are usually planted deep. They are placed about 5 inches deep with the planter and then are further hilled or ridged until they are 6 to 9 inches below the surface of the ridge. Often the potatoes are not hilled or cultivated after the plants emerge, partly because of daily irrigations in alternate furrows, which are begun very soon after the plants come up. This investigation deals with the effect of planting depth upon yield and tuber set of potatoes under the type of culture mentioned above.

Review of Literature

Experimental evidence on the effect of planting depth on potatoes as grown in Kern County is meager. General bulletins and texts usually advise planting the seed pieces 3 to 4 inches deep for the early crop, and 4 to 5 inches for the late crop. Plantings should be shallower in heavy

[1]The author acknowledges his indebtedness to Mr. George J. Harrison, Agronomist, U. S. Cotton Field Station, Shafter, California, for providing the land and for aid in the growing and harvesting of the potatoes planted at Shafter.

or wet soils than in light or dry ones. According to Fifield (1), most Florida growers plant 1 to 2 inches below the ground level. In studies there, depth of planting had no correlation with yield; but there was the probability of securing higher yields from shallow plantings in years of adequate soil moisture than during dry seasons. Hardenburg (2) in New York, states that planting 3 to 4 inches deep in the lighter soils gives increased yields and less sunburn than shallower plantings. All these recommendations are for areas where the plants are ridged or hilled after the new tubers have set and for areas where the growers must get the plants up quickly for the sake of controlling disease, particularly rhizoctonia.

Moore's (4) experiments, extending over a period of three years, showed that deep planting speeded the rate of come-up, presumably because of a greater and better distribution of moisture supply. Shallow covering also hastened the come-up, whether the seed pieces were planted deep or shallow. The differences were relatively small, however, amounting to only a few days. Shallow planting followed by ridge culture gave the highest percentage of U. S. No. 1 potatoes, the difference being largely the result of a reduction in sunburn. The number of tubers per plant decreased as the ridge was made higher.

Hardenburg (2) concluded that irrespective of the depth, tubers tend to develop at the 4-inch level. In this respect there may be varietal differences; for example, according to Le Clerg (3), Katahdin tends to produce its tubers near the soil surface.

Methods

Experiments were conducted for 3 years at the U.S.D.A. Cotton Experiment Station at Shafter and for 2 years at the University Farm at Davis. The soil at Shafter is a Hesperia sandy loam ideally suited to potato production; that at Davis a Yolo silt loam,—too heavy for good production. These extremes were used because soil type might have an appreciable effect on depth of tuber set, sunburn, and possibly yields. Certified seed of the White Rose variety was used in all tests. At Shafter the ridges were formed with a potato planter, and 500 pounds per acre of ammonium sulfate fertilizer was simultaneously applied. The ridges were then made to a height of about 7 inches above the furrow by means of a cultivator. At Davis all ridges were made with a lister, and no fertilizer was used. The seed pieces were planted by hand,—12 inches apart in the row. Depth of planting as given refers to the inches of soil above the top of the seed piece. After the seed pieces were planted, no more dirt was thrown on the

ridge. The plots consisted of single rows,—125 feet long at Shafter, and 70 feet at Davis. There were three plots of each treatment each year at Shafter, and two at Davis.

The planting dates at Shafter were as follows: February 26, 1942; February 24, 1944; and February 20, 1945. At Davis the dates were February 29, 1944, and February 23, 1945. Harvest dates at Shafter for the three years were the 8th, 14th and 19th of June, respectively. At Davis the comparable dates were the 1st of July, 1944, and the 5th of July, 1945. At Shafter the potatoes were irrigated once,—soon after planting. Daily irrigations in alternate furrows were begun when the plants were about 8 inches high, and continued until 1 week before harvest. At Davis the potatoes were irrigated only four or five times during the season.

Results and Discussion

Table 1 indicates how the depth of planting affects the total yield. The highest yields were obtained from 4 and 6-inch plantings, whereas yields from the 9-inch were definitely inferior, both at Shafter and Davis. In 1944 and 1945 there was little difference among the 2-, 4-, and 6-inch plantings at Shafter; but in 1942 the yields from the 2-inch were much lower. This difference was attributed to delayed emergence of the shallow planting. Tubers that developed below 6 inches showed greatly enlarged lenticels, which detracted from their appearance. This was presumably due to their development in wet poorly-serated soil.

Table 1. *Effect of planting depth on yield of tubers*

Locality and Planting Depth (Inches below Surface of Ridge)	Total Yield of 100-Pound Sacks per Acre			
	1942	1944	1945	Average[1]
Shafter				
2	207	271	303	290
4	406	265	313	328
6	415	274	334	341
9	373	252	241	289
Davis				
2	...	115	141	128
4	...	152	147	150
6	...	122	179	151
9	...	92	143	118

[1]Difference required for odds 19 to 1: for averages at Shafter, 50; at Davis, 34.

The effect of planting depth on the yield of marketable potatoes is seen when one compares the percentage of sunburn tubers, as given in table 2, with the total yield. In both soils there was a much higher percentage of sunburn in the 2- and 4-inch plantings than in the deeper plantings. At Shafter there was slightly less sunburn at the 9-inch planting than at the 6-inch; but at Davis the two treatments gave practically the same results. The large amount of sunburn resulting from the 2-inch planting is shown in that 31 per cent of the tubers were affected with sunburn at Shafter and 44 per cent at Davis.

TABLE 2. *Effect of planting depth on sunburn of tubers*

Locality and Planting Depth (Inches below Surface of Ridge)	Percentage of Tubers Showing Sunburn			
	1942	1944	1945	Average
Shafter				
2	10.9	39.9	42.2	31.0
4	8.8	20.7	19.6	16.4
6	7.8	10.8	6.5	8.4
9	7.3	2.8	4.6	4.9
Davis				
2	...	67.6	20.9	44.3
4	...	31.7	12.4	22.1
6	...	8.7	5.9	7.3
9	...	16.0	0.7	8.4

Considering the amount of sunburn, one readily sees that the highest yield of marketable tubers per acre resulted from the 6-inch planting, and the lowest from the 2-inch.

Table 3 shows how the planting depth affects the number of potatoes harvested per hill. In both soils the number per hill became smaller as the depth of planting was increased. Over 30 per cent more tubers, by number, were harvested from the 2- than from the 9-inch planting. On the other hand, potatoes from the deeper planting were much larger in size.

Planting depth also affected the depth of tuber set, as is shown in table 4. The figures given refer to the distance from the surface of the ridge down to the center of the tuber. These measures were made on 10 hills of each replicate each year, and were taken about one month before harvest and before the tubers had been displaced by crowding one another. At the 2-inch planting, 61 per cent of the tubers set less than 2 inches below the surface at Shafter; and 76 per cent at Davis. With this shallow planting, practically no tubers developed below

TABLE 3. *Effect of planting depth on average number of tubers per hill*

Locality and Planting Depth (Inches below Surface of Ridge)	Average Number of Tubers per Hill			
	1942	1944	1945	Average
Shafter				
2	5.0	4.7	4.7	4.8
4	5.6	3.6	3.9	4.4
6	4.7	3.3	3.6	3.9
9	4.1	3.3	2.9	3.4
Davis				
2	...	4.3	4.6	4.5
4	...	4.4	3.5	4.0
6	...	3.4	4.1	3.8
9	...	2.9	3.2	3.1

6 inches. In the 2-, 4-, and 6-inch plantings, most of the tubers developed just above the seed piece. In the 9-inch planting, about 50 per cent were located 6 inches or more below the surface. In summary, the deeper the seed piece was planted, the deeper was the resultant set. This is contrary to the findings of Hardenburg (2), who has stated that irrespective of depth planted, tubers tend to develop at the 4-inch depth. Since the tuber-producing stolons form above the seed piece, it would seem that tubers would also tend to develop there. In order that the tubers be located below the seed piece, the stolons would first have to grow downward. The White Rose variety used in the study developed most of the tuber-forming stolons about an inch above the seed piece.

TABLE 4. *Effect of planting depth on depth of tuber set; average of 3 years at Shafter, 2 years at Davis*

Locality and Planting Depth (Inches below Surface of Ridge)	Percentage of Tubers at Specified Depths				
	Less than 2"	2-4"	4-6"	6-8"	More than 8"
Shafter					
2	61	26	12	1	0
4	15	56	27	2	0
6	4	31	45	18	2
9	1	15	35	33	16
Davis					
2	76	23	1	0	0
4	33	50	15	2	0
6	9	14	55	22	0
9	9	9	22	31	29

Data on the effect of depth upon plant emergence are given in tables 5, 6, and 7. These data were taken during 1944 and 1945 at Shafter and in 1945 at Davis. In 1942, according to other observations at Shafter, the 2-inch planting was very slow in emerging, presumably because the soil surface dried out. In all other cases, the deeper plantings tended to emerge later. Differences in emerging rates were most pronounced during the first few days and soon tended to disappear. By one month after first emergence, there were no noticeable differences in size of plants coming from the different depths. With the deeper

TABLE 5. *Effect of planting depth on plant emergence at Shafter, 1944; potatoes planted February 24*

Planting depth (Inches below Surface)	Percentage Emergence on the Following Dates				
	March 26	March 28	March 30	April 1	April 10
2	76	83	86	88	96
4	70	80	85	87	97
6	63	70	73	76	98
9	47	72	77	81	97

TABLE 6. *Effect of planting depth on plant emergence at Shafter, 1945; potatoes planted February 20*

Planting Depth (Inches below Surface of Ridge)	Percentage Emergence on the Following Dates					
	March 31	April 2	April 6	April 10	April 17	April 25
2	66	82	94	95	98	99
4	37	57	82	88	98	98
6	38	56	82	85	95	99
9	3	10	46	60	78	98

TABLE 7. *Effect of planting depth on plant emergence at Davis, 1945; potatoes planted February 23*

Planting Depth (Inches below Surface of Ridge)	Percentage Emergence on the Following Dates			
	April 23	April 30	May 5	May 10
2	33	70	96	97
4	46	82	92	95
6	18	58	87	96
9	7	47	81	94

planting some stolons developed all along the stem below the ground at intervals of approximately 2 inches.

As is readily seen, the large amount of sunburn on tubers of the shallow planting can be accounted for by their shallow setting. Deep setting also helps to control certain insects and diseases. Injury by the tuber moth is much lessened if the potatoes develop below any surface crack in the soil. There is much less likelihood that the spores of late blight may be washed to the tubers that develop deep. Weather and conditions of the seed when planted affect emergence as much as does depth of planting. If the seed is relatively dormant or the weather cool, the process will be slow; the time from planting to first emergence will far exceed the time from the first to final emergence. One sees the effect of weather when comparing some of the results obtained in 1945: plants at Davis emerged about 3 weeks later than plants from identical seed lots at Shafter. The final stand was not affected by planting depth, and good stands were obtained in all cases.

Summary

The results of three years' depth-of-planting tests with potatoes grown at Shafter on a light sandy soil and of two years' tests at Davis on a heavy silt loam soil are presented. All comparisons were made when the top of the seed piece was planted 2, 4, 6, and 9 inches below the surface of the ridge.

Four and 6-inch plantings produced higher total yields than did the 9-inch. The total yields from the 2-inch planting were only slightly lower than for the 4- or 6-inch; but the yield of marketable tubers was much lower, because of sunburn.

The percentage of sunburned tubers became less as the planting depth was increased up to 6 inches. The 9-inch plantings differed only slightly from the 6-inch.

The number of tubers per hill became smaller as the depth of planting was increased.

Size of tuber increased along with the depth of planting.

Depth of tuber set also increased with depth of planting. Most tubers tended to develop immediately above the seed piece.

When there was sufficient moisture the plants from shallow plantings tended to emerge first.

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SECTIONAL NOTES

CALIFORNIA

Insofar as the chairman of the California AAA knows, the goal for California Early potato acreage will be 53,000 acres. This compares with approximately 73,000 acres produced in 1945. On this same basis of reduced acreage goals, Kern County would probably receive less than 40,000 acres. Just what reaction the growers of this county will take is not known. We doubt, however, if they will accept a reduction of approximately 30 per cent to the extent that they will not cooperate wholeheartedly with the program unless some regulatory measure is put into operation at a later date.

It is now the first of November and within 30 days from today our growers will be planting potatoes, and unless the full Federal program is known prior to the first of December our growers will not be in a position to cooperate as the potatoes will be planted. The potato growers of this county need to know what the program is today —not on the 1st of December, January, or February, for most potato growers are now receiving their seed and fertilizers, and beginning the preparation of their seed beds.

You might ask what the acreage will be in 1946. If such a question should be asked, the answer should be "wait and see." (Nov. 2). —M. A. LINDSAY.

IDAHO

Idaho harvested the largest potato crop in the history of the state. However, the November estimate was dropped from 43,650,000 to 42,680,000 bushels. The early frosts in September accounted for this drop in estimate.

The harvest was completed with very little field frost damage,—thanks to favorable weather conditions. The quality of the crop is probably slightly above average except that there is a higher percentage of undersized tubers than normal. Baker size tubers should demand a good premium this season.

The movement of the early crop was slightly ahead of last year. During October shipments lagged to a certain extent. This condition was due to the shortage of labor. Nearly all labor was in the harvest fields during this month. At the present time the movement of potatoes is satisfactory. The market is firm, large stock selling about ten cents below what would have been ceiling price.

Idaho has a large crop of certified potatoes, approximately fifty per cent larger than last year. Ninety-five per cent of the certified potatoes are of the Russet variety. If there shouldn't be enough

demand for seed potatoes, part of the seed crop will go on the commercial market towards spring.

It is too early to forecast for 1946. It seems very likely that there will be a considerable reduction in acreage, — to what extent will depend how the crop is cleaned up in the spring. A draggy spring clean up would further reduce plantings. (Nov. 13). — JOHN L. TOEVS.

INDIANA

Our potato harvest is practically completed. The unusual season caused many problems to come to our attention, as we had attacks of both early and late blight which is going to cause some loss in the storage of potatoes. We have also found that some of the vines of the Sebago, Sequoia, as well as the Katahdin and Chippewa, remained green over a longer period than usual, and consequently resulted in more blight damage to the vines for some of our growers, who harvested before the vines had dried up. If other sections of the country are having the same trouble, it is quite evident that the big crop of potatoes produced this past year may not go into the bag and I hope that no one is left holding the sack.

In seven plots on mineral soil comparing the Irish Cobbler, Katahdin, Sebago and Sequoia, the yields increased in the order named and to some extent the blight damage corresponded with the variety. In other words, the Sequoia seemingly suffered more from the late blight than did the other varieties because the foliage remained green until harvest time.

We have quite a few growers who have grown more than the 500 bushels per acre mark this year, and the quality in many of these fields is better than we have had in the past. There are a lot of potatoes available, the price is firm and the demand is fair to good. (Oct. 26).— W. B. WARD.

MICHIGAN

Michigan's crop is finally harvested and under cover. The rainfall in early October slowed up digging which left a large part of the crop to be harvested after the 15th of October. We were very fortunate to have nice weather the last of October to complete our harvesting operations. To date we have had only a light field frost and the damage from frost is slight.

The movement to market has been very slow, only the stocks stored in temporary storages are moving out. Growers are reluctant to move stock out of good storage under present conditions. Hence, Michigan's carlot shipments are about one-half that of a year ago.

Growers are "up in the air" over the support price. Generally

the growers feel that they have had a "fast one" pulled over them. Nothing was said when they were asked to produce this crop that it would be necessary to take a loan in order to receive benefits of a support program.

The Certified Seed crop is of good quality but yields are below those of a year ago. The set was large, which resulted in smaller tubers. Michigan had an increase in seed acreage this year but the total tonnage to be shipped will not reflect the amount that the increased acreage would indicate.

Rejection in field inspection was not heavy. For the past two years all certified seed fields have been inspected at digging time. The bin inspection will be completed by the 1st of December.

The Russet Rural is still the most popular variety in Michigan and it is interesting to note the increased interest in this variety shown particularly by the chip manufacturing people. Some of the chip people are buying Russet Rural seed to distribute in areas where they secure their stock for chipping. (Nov. 1).—H. A. REILEY.

NEW JERSEY

Practically all of New Jersey's bumper crop, estimated at 12,960,000 bushels has now been shipped. The government has purchased about 3,200 cars of graded stock and the equivalent of approximately 1,400 cars, or 30,000 pounds of bulk potatoes in its price support program. Most of the graded potatoes have been distributed to state and county institutions, although some are being made into starch or used for animal feed. The potatoes that have been shipped in bulk are being made into industrial alcohol. Approximately 50 carloads containing over 600 sacks each are being shipped daily for this purpose and it is expected that this program will be completed by the 1st of December.

The United States Department of Agriculture has recommended that New Jersey should reduce her commercial potato acreage from the 62,000 planted in 1945, to 49,200 acres. This is a reduction of 12,800 acres or more than 20 per cent.

There will undoubtedly be a voluntary reduction in acreage,—varying from 10 to 15 per cent,—but it may not reach the rather sharp reduction suggested by the government.

New Jersey's seed potato crop has produced somewhat better yields because of the very extended period of warm weather, than was previously expected and a fair supply of good seed is available.

Seed shipments from Maine are arriving in increasing amounts and most of the seed is not only in good condition but is also of a more desirable size than usual. (Nov. 15).—J. C. CAMPBELL.

NEW YORK

Exceptionally wet weather throughout October made it difficult for many growers in Central and Western New York to harvest their potato crop. As of the 10th of November, several of our large growers report that some of the acreage has not been harvested, as yet, and may never be. Yields have been variable,—some excellent, many disappointingly low. The Northern New York crop is reported to be good both in quantity and quality. Growers in Long Island have probaby harvested the biggest total yield and the finest quality in its long history. Fewer potatoes have been stored on the Island than usual,—partly because of the willingness of the government to buy for surplus diversion. Since the surplus was disposed of, prices have improved and the crop is being marketed in a more orderly fashion.

There is a feeling on the part of many growers that the support price program and to a similar extent the direct purchase program encourages the less efficient grower to continue in business and discourages sound economical planning for the post-war years. The Brewster Bill which is now before Congress, to make potatoes a basic commodity, will have a hearing on the program of the Empire State Potato Club at Buffalo on January 3d. Those who believe in free enterprise and less government control of acreage and marketing quotas, are not favorable regarding the passage of this bill.

Plans are now about complete for the 18th annual meeting of the Empire State Potato Club. The convention and state-wide competitive potato show will be held at Hotel Statler, Buffalo, on the 3d and 4th of January. Friends from other states are cordially invited to attend and to participate in the discussions. (Nov. 10).—E. V. HARDENBURG.

OREGON

Our potato harvest was practically completed by the 1st of November. The season has been disagreeable with many labor difficulties; shortage of cars, cancellation of contracts, etc. Shipments have been heavy to date. The quality has been about average. The total shipments estimated will be one thousand to two thousand cars less than 1944. Undoubtedly, demand for good certified seed will be very acute. Our prospects point toward the fact that the acreage planted next year will be considerably less than at the present. (Oct. 30).—C. A. HENDERSON.

Despite the war being over, we have had the worst labor situation of any of the war years. Potato harvesting in concentrated potato

growing areas requires a large number of itinerant laborers, or at least workers not employed on these farms the balance of the year. Workers were mostly restless and inclined to wander from farm to farm or just fail to show up at all. Many folks who commonly spent about two weeks harvesting, have spent a month or more with crews varying widely in numbers from day to day. Farmers are disgusted and worn out and at present are inclined to cut their next year's acreage drastically. They may not feel the same way by next spring. Our present prospects point to a significant drop in acreage for next year.

No. 1's are selling at the ceiling price, or at least at what the ceiling price would have been if we had a ceiling price, but No. 2's are far below the old ceiling. They are "going begging" at not more than one-half the price for No. 1's. Very little certified seed has been spoken for, except White Rose. Our White Rose crop is nearly sold out, at ceiling prices. Our foundation seed of White Rose has a requirement that prevents it from being classified as foundation seed until tested in a winter seed plot and this is interfering to some extent with marketing, because buyers want delivery in December; whereas, southern test-plot readings will not be available until February.

There has been some confusion about deliveries on potatoes contracted at ceiling prices by dehydrators, based upon governmental purchases from the dehydrator. In at least one case, the governmental purchasing agency intends to take these potatoes for U. S. Army and other government needs and thereby save the dehydrator a loss. (Oct. 29).—E. R. JACKMAN.

SOUTH DAKOTA

The potato harvest was completed in South Dakota with practically no frost damage. A heavy freeze on the 28th of September nipped some of the potatoes near the surface but the damage was very small. Potato digging was completed on the 20th of October and the next heavy freeze did not occur until the 30th. Shipments to date have not been as heavy as last year and every permanent store house is filled to the roof. Our truck movement was heavier than last year with many of the potatoes going to other sections of South Dakota. The principal producing area centers around Clark and Watertown in the northeastern section of the state.

It is estimated that approximately 50 field pits were constructed for temporary storage and these potatoes are under loan to the Commodity Credit Corporation. They are being moved this week (November 13) to a Government plant at Muscatine, Iowa, for manufacture. (Nov. 17).—JOHN NOONAN.

Errata

In the May, 1945 issue in the article by W. A. Kreutzer, W. J. Henderson, and George H. Lane, entitled, "The Comparative Effectiveness of Certain Cutting Knife Treatments in the Control of Ring Rot of Potatoes,"—table 1, page 130, after treatments 15 and 18, should read "0.05 per cent" instead of "0.5 per cent"; and the first line on page 131 should read "$\frac{\Sigma(axb)}{T}$" or $\frac{S(axb)}{T}$ instead of "$\frac{(axb)}{T}$".

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EMPIRE — A BLIGHT RESISTANT VARIETY

DONALD REDDICK and L. C. PETERSON

Cornell University, Ithaca, N. Y.

Almost as soon as potato blight (caused by *Phytophthora infestans*) became a menace to potato culture, attempts were made to find plants that might be resistant or immune to the disease. The history of these attempts has already been reviewed in earlier articles in the JOURNAL and need not be repeated here. Suffice it to say that the early idea of a method of permanent control of the disease by the use of a resistance factor has persisted during the century of blight and that at the present time all of the persons in the world who are interested in the problem are employing essentially the same principle. This consists of locating species which carry an immunity factor, crossing and backcrossing with domestic varieties to eliminate objectionable wild characters, eliminating susceptible plants and selecting horticulturally acceptable types for propagation.

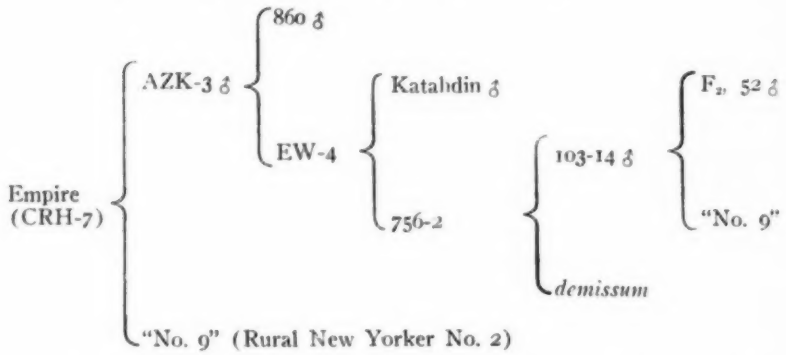
ORIGIN

The Empire potato was produced as the result of a series of crosses made for the specific purpose of securing new commercial varieties which would combine the immunity to blight of the species *Solanum demissum* Lindley with the desirable horticultural and culinary characteristics of the commercial varieties commonly grown in northeastern United States of America. The difficulties involved in potato breeding for any purpose are too well known to require exposition at this time but it may be observed in passing that a program of work cannot be set down in advance and adhered to because of such vagaries as pollen

sterility, non-receptivity, incompatabilities, etc. These troubles are only enhanced when inter-specific crosses are attempted and are made even greater when one of the parents of the original cross happens to be a plant of tropical origin and one possessing a full complement of 72 chromosomes instead of the 48 chromosomes common to all of the varieties in commercial production in most parts of the world. The methods employed in the production of immune plants have been described in some detail in an earlier issue of the JOURNAL (*20*: 118) and need not be repeated here.

Empire was first grown in 1940 at the Cornell University Agricultural Experiment Station, Ithaca, New York. It originated as a cross of Rural New Yorker No. 2 with a hybrid seedling which, except for its sensitiveness to drought conditions, might itself have received the name.

The parentage is indicated by the following formula:



In this expression No. 9 is a varietal name which was given to a high yielding selection made from Rural New Yorker No. 2. The particular culture of *Solanum demissum* employed was produced from seeds collected by Erlanson and Souviron at El Desierto, D. F., Mexico, in January 1931 and distributed by the Office of Plant Introduction, U. S. Department of Agriculture, under the number 91270. In general, it has the appearance of the type specimen of Lindley as it occurs in the Lindley Herbarium at Cambridge, England. 103-14 was an unnamed seedling, long since lost, obtained as a selection from a cross of "No. 9" by "52," the latter an unknown variety found as a single green plant in a blighted field near the hamlet of Belmont in the Vosges above Strasbourg in France. Its resistance to blight at Ithaca was found to be only nominal. 860 is an unnamed seedling obtained from F. A. Krantz in Minnesota under the number 41-2-10-1. It has been used

extensively because of its consistent record for drought tolerance. The strongly rugose leaflet of this seedling is a character which persists in many of its progenies and is strikingly manifest in Empire. Following each cross, a crop of seedlings was grown, the plants susceptible to blight were eliminated by inoculation, the immune plants were transferred to the field and selections were made primarily on the basis of size, shape, and appearance of tubers.

Description

Habit: Plants emerging weak, spindling, open, becoming tall (50-60 cm.); semi-erect, spreading by axillary growth and becoming dense; stems pale green, thin, weakly erect, becoming thick, solid throughout; pubescence sparse consisting of very short white hairs; wings insignificant, knife edge; nodes not thickened, not colored; internodes short (3-5 cm.); stipules 1 or 2, usually 2, green, small but enlarging if the axillary bud develops and appear as a pair of sessile leaflets; leaves short (18-23 cm.), close; leaflets, 3-5 pairs, usually 3, pale green, extremely rugose especially when young, elliptic, scantily pubescent, acuminate tips, mean length of blade 60.95 ± .185 mm., mean width 44.2 ± .427 mm., index 72.689 ± .73; petiolule 10-12 mm.; folioles numerous, usually one leaf-like pair (secondary leaflet) between each pair of primary leaflets and an additional pair (or 1 or 3) of small sessile ones; inflorescence erect, short (60-80 mm.), sparsely branched (8-11 flowers); peduncle green, slightly flattened, with sparse short, white hairs; pedicle medium length, green, sparse short fine hairs; articulation inconspicuous, slightly swollen, calyx green, short, acuminate, sparse white pubescence; corolla small (18-22 mm.) white but lavender tinted at sinus, rotate, short acuminate teeth, shallow sinus; stamens orange, exceeding the corolla in the buds, medium size; pore present, becoming dark with age; pollen fertile; style long, emerging before flower opens; stigma globular, capitate, green; tubers, large, kidney, cream buff (R.) mean weight (100 tubers) 234. ± 1.14 gm. mean length (100 tubers) 97.43 ± 0.81 mm., mean width 75.09 ± 0.54 mm., mean thickness 54.7 ± 0.69 mm.; indexes, width to length 76.635 ± 0.7; thickness to length 56. ± .59, width to thickness 72.38 ± 0.65; skin very fine flaky, self-colored; eyes fleet, same color as skin; eyebrows long, thin, curved, inconspicuous; flesh white; boiled tuber white (no darkening), fine grain, mashes down smooth, slightly mealy to mealy, good flavor; maturity, main crop.

Characteristics

The cross No. 9 x AZK-3 was designated CRH in an alphabetic system of entry. Selection No. 7 harvested on the 27th of September 1940 was a large green plant and bore 4 tubers, 2 the size of a hen's egg and 2 small ones. In 1941, 4 plants were grown. They were considered "good" on the 29th of July, and "excellent" on the 20th of August. Each time they were recorded as "drought tolerant." The hills yielded 4 to 6 tubers of commercial size and a notation was made of the unusually satisfactory appearance of the tuber. Test samples were inoculated in the greenhouse each year and always gave an immune reaction. In 1942 scions of the variety Green Mountain were set on potted plants. Many other hybrids were similarly treated at the same time. After the usual 21 days some hybrids were showing top necrosis, a typical lesion for virus x which is carried passively by Green Mountain, but Empire did not react.

Empire, as grown in the field, has several of the characteristics of Rural New Yorker No. 2. Apical dominance is pronounced and usually only 1 or 2 stalks are developed regardless of the number of eyes on the seedpiece. For nearly 3 or 4 weeks after emergence the stalks appear to be weak. One is reminded of the weak, spindly appearance of Rural New Yorker No. 2 in its early stages of growth. As time goes on the stems become thick and stand erect, axillary shoots fill in the voids and a fine large plant results.

In 1942 the seedling was grown in 10-hill units in 4 widely separated places (Sagaponack on eastern Long Island, Lake Placid in the Adirondacks, Virgil in central New York and Fillmore in western New York). The yields in pounds were very satisfactory. It was noted that not many (3-6) tubers were set but that all tubers were large. The culinary quality of the crop in all four places was entirely satisfactory: white flesh, dry consistency, slightly mealy to mealy, and a "good" flavor. In 1943 the seedling was again grown in 3 places in 15-hill duplicate lots with any surplus in a buffer row.

Yield tests were conducted in 1944 and in 1945 in the aforementioned areas of widely differing climatic conditions. In 1944 all of the plots were subjected to approximately 3 weeks of heat with the thermometer reaching into the 90's (F) practically every day. Without exception Empire yielded as well or better than the standard varieties of the localities mentioned. When blight was a factor in the standards as it was in 1945, Empire exceeded the standard by as much as two to one.

Adaptation

The records show the variety to be adapted to most parts of New York, but it is too late in maturity to be at its best on Long Island. The same may be said for the Adirondack region where the plants get killed by frost before natural maturity sets in. In general, Empire may be considered a substitute for Rural and may be expected to do well in the areas where Rural has been standard. Incidental tests, made in Florida, indicate that the variety has a long rest period which would have to be broken by some special treatment in order to make it of value as a winter crop potato.

Dissemination

All of the stock of Empire has been placed in the hands of the seed potato growers who collaborated in the tests and will be increased by them just as rapidly as possible. Every assistance will be given these persons in further yield testing, roguing, and in any other possible way in order to make the variety generally available at an early date. No one at the Experiment Station has any stock of the variety. None of the growers who is increasing Empire cares to dispose of any stock at the end of 1945 but in October 1946 stock will be available and the names of holders will be made public at that time.

Stability of Blight-Proof Character

Empire has been tested repeatedly for immunity by inoculations made on young plants in the greenhouse. The conditions under which the inoculations were made are considered far more severe than would prevail in nature in that the spore-load applied has been excessive, the culture used for the inoculations was much more virulent than the one commonly prevalent in North America (at least it produced lesions on a considerable number of hybrids which were not affected by the latter culture, and the air of the inoculation chamber was maintained at constant saturation for a period long enough to permit infection. Nevertheless, blight lesions have been found on Empire on two occasions in the field. The lesions were small and few in number and were not detected by experienced potato growers. They appeared very late in the season. *Phytophthora infestans* was definitely identified. At present it is considered likely, from the circumstances, that these infections resulted from the build-up of the parasite from the prevalent culture

through an intermediate hybrid (CRD-8) which is known to be very highly resistant but not immune. In the absence of CRD-8, Empire remained blight-free in a field in western New York where the blight appeared early and became the most destructive ever experienced in 30 years of personal observation by the grower. Investigations, as yet not published, indicate that no biological race comparable to the "S" form as described by Müller is involved.

When deciding in January 1945 to "release" Empire to growers of certified seed for increase and distribution, it had to be assumed that elimination of the intermediate from the field would prevent increase in virulence of the parasite and thus leave Empire entirely free from blight, *i.e.*, a blight immune variety. In the meantime, however, certain other considerations have arisen which reflect doubt on some of the conclusions drawn from earlier work so that it must be assumed for the present that Empire ultimately may break down. As a matter of fact, such an assumption will have to be made in the case of any introduction of a blight-proof potato until long experience indicates that a breakdown does not occur. The decision to release Empire also was based on an opinion formed after 15 years' observation of a great many hybrids; on extensive experience with virulent cultures of the parasite; and on an intimate knowledge of the factors involved in the outbreak of blight epiphytotics in the areas where Empire is likely to succeed.

THE CAUSE OF PURPLE-TOP OF POTATOES, AS INDICATED BY A STUDY OF ITS DISTRIBUTION WITHIN FIELDS

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A pathological condition, purple-top of potatoes has been known since 1915 (Muncie 1940) but the cause of this disease is still obscure. Muncie (1932) Long (1935), Orton and Hill (1938) Leach and Decker

[1]Formerly and at the time of the present work in the Division of Entomology, Canadian Department of Agriculture.

[2]Officer-in-Charge Dominion Entomological Laboratory.

(1938) and Younkin (1943) suggested that the infection on potato was related to some insect injury.

Purple-top has been, at times, the occasion of sufficient concern to potato growers in the Maritime provinces of Canada that it now merits study. The present work considers the distribution of the condition within a field to see what evidence is afforded of the causal mechanism, of which the identity—whether a contagious organism or damage by an insect is uncertain. The data considered are the number of affected plants within each of many tuber-units, which are a group of potato plants grown contiguously in a row, derived from parts of a common mother tuber, and distinguished from other clones. The general method by which the problem is attacked can be followed if it is first realized than an inherited pathological condition would ordinarily appear in either none or else in all members of a tuber-unit; that a rapidly contagious condition would tend to the same phenomenon in view of the contiguity of the plant members of a tuber-unit; that a condition peculiar to, say, plants derived from the stem end of the mother tuber would appear regularly in each tuber-unit, and so forth. Conversely, given the observed distribution of the condition within tuber-units, it should be possible to judge closely the type of causal mechanism involved.

It is necessary first to make clear what is meant by purple-top, which resembles very closely summer rhizoctonia, in that the bases of the nodes are prominently swollen and give rise to aerial tubers, and it is quite possible that hitherto both have been classed as rhizoctonia. Plants with purple-top do not, however, develop corticium spores on the basal parts above ground nor is there any evidence of the *Rhizoctonia* fungus in the cankered underground tissue. In general the symptoms of purple-top first appear at the tip of the plants, the newly forming leaves fail to expand normally, and the leflets roll upward with the heaviest roll at the base. This stage is illustrated in Fig. 1. Apical dominance gives way very largely to axillary growth of stem shoots; the plants take on a rosette appearance. Tubers under plants affected with purple-top almost invariably have the stolons attached firmly and in severe cases some of the tubers are soft or flabby. The symptoms of purple-top vary somewhat according to variety; Green Mountain shows less marked symptoms than do other varieties such as Katahdin, Sebago, Irish Cobbler and Warba, which from their pigmented nature show red or purple-tinted leaves in affected plants; the coloration is evident at the sides of the leaflets where curling is most evident; in varieties like Green Mountain, which lack pigmenta-

tion, a peculiar chlorosis is present in the upper leaves. Later in the season the stems of the plant take on a bluish color and with the first touch of frost they become black. A later stage of purple top is shown in figure 2. Toward the end of the growing season affected plants often show a browning in the vascular tissue of the extreme lower portions of the stems and this browning often extends into the stolons also.

Purple-top was first brought to the attention of potato growers in 1939, when it was present to a moderate extent. In 1940, it was also prevalent. In 1943, it was found to a very slight extent in a few fields near Charlottetown. During 1942, purple-top was observed commonly abundant and present to some extent in all fields examined. The varieties Sebago and Katahdin suffered most, Irish Cobbler moderately to severely, and Green Mountain least. In many cases the condition caused a considerable reduction in yield.

Counts for the present study were made on two farms where plantings had been by tuber-units. On the first farm, that of *Mr. E. Foster of Marshfield, Prince Edward Island, 264 tuber-units were planted in

FIG. 1. An early stage of purple-top.

4 rows and comprised 1368 plants of which 486 showed purple-top. These rows were on one side of a large field of potatoes with a fence along the opposite side. On the second farm, that of *Mr. C. W. Ramsay of Belmont, Prince Edward Island, 516 tuber-units were planted in 5 rows and comprised 2334 plants of which 110 were affected. The rows were on one side of a field of potatoes the same as on the first farm. The potatoes were of the variety Sebago.

Before it is possible to consider the distribution of purple-top within tuber-units, on the lines originally indicated, assurance is necessary on the homogeneity of the fields, particularly since the effect is often manifestly worse in one part of the field than in another. Accordingly, the fields were broken into quarter-rows, in the sense that each row was broken into 4 parts, each containing so nearly as

*Thanks are due these gentlemen for the courtesy of their co-operation.

FIG. 2. Purple-top in a later stage of development.

possible, the same number of tuber units. For each of the quarter-rows, the number of sound plants and the number of plants with purple-top are shown in table 1 for the 2 farms, previously mentioned. In

TABLE 1. *The number, N, of sound plants and the number, P, of those affected by purple-top, by quarter-rows.*

		FARM A				
	Quarter	Row I	Row II	Row III	Row IV	TOTALS
N	1	73	43	64	47	227
P		14	36	26	41	117
N	2	71	47	59	36	213
P		16	36	35	36	123
N	3	70	54	58	41	223
P		20	35	29	40	124
N	4	67	46	55	51	219
P		19	39	30	34	122
N	Totals	281	190	236	175	882
P		69	146	120	151	486

		FARM B					
	Quarter	Row I	Row II	Row III	Row IV	Row V	TOTALS
N	1	134	99	107	114	109	563
P		10	10	13	10	6	49
N	2	105	103	117	115	117	557
P		4	5	3	6	5	23
N	3	108	121	115	116	120	580
P		5	2	6	3	2	18
N	4	101	105	99	113	106	524
P		3	1	4	6	6	20
N	Totals	448	428	438	458	452	2224
P		22	18	26	25	19	110

table 1, the marginal totals for each field were studied particularly. For Farm A, it can be seen that there was a considerable irregularity, which is statistically[3] significant, in the low incidence of row 1, which

[3]For Farm A, the totals by rows of afflicted and sound plants may be tested as a 2 x 4 contingency table yielding the statistic $X^2 = 64.50$ ($f = 3$) and the probability P x 2. The chance of such a result is below .000,000,5 and hence very clearly significant.

was on the edge of the field. In row 1, only 20 per cent of the plants had purple-top, whereas the remaining rows showed 41 per cent. For Farm A, the totals by quarter-rows may also be considered in the same way as those for rows when, however, there is no evidence[4] of heterogeneity. For Farm B, on the other hand, there was no heterogeneity between rows, but clearly[5] heterogeneity in the summation the other way, *i.e.*, by quarters. The present results show that the causal mechanism of purple-top may operate variously over fields, as was anticipated, but also that it can operate with equal freedom along and across rows of potatoes. For immediate purposes it may be noted that on Farm A, tuber-units must be compared only within the same row, and on Farm B only within the same quarter.

Since on Farm A the rows showed no heterogeneity between the quarters, it is appropriate to consider the incidence of purple-top within each row, disregarding the quarters. Within rows, the material must first be sorted, as in table 2, according to the size of tuber-unit (2 plants, 3 plants, etc. to 8 plants) in each row. Thus, in table 2, it will be seen that in row one there was only one tuber-unit of 2 plants, and it had one plant affected by purple-top; in the same row there were 40 tuber-units of 4 plants, and of these 16 had no plants affected, 20 had 1 plant affected, 3 had 2 plants affected, and 1 had 3 plants. For each occupied cell in table 2, there is a distribution, of the sort cited, for affected plants, and it only remains to consider whether that distribution is random or whether there is a counter-tendency for either none or all the plants of a tuber-unit to be affected. It is possible to consider the point raised by calculating for each cell the random distribution[6] and comparing it with the observed. This comparison is illustrated in table 3 for the cases of tuber-units with 6 plants (the material of the 6th column of table 2 is involved; it will be seen at once that the correspondence is reasonably satisfactory. The

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[4] $X^2 = .53$ ($f = 3$) and there is clearly no significant heterogeneity ($P\ X^2 > 8.$).

[5] For Farm B, there was no heterogeneity between rows ($X^2 = 1.99$, $f = 4$ and $P\ X^2 > .7$) but clear heterogeneity between quarters ($X^2 = 20.67$, $f = 3$ and $P\ X^2 < .0002$).

[6] The random distribution used is the binomial

$$m\ (q + p)^n$$

where m is the number of plants per tuber-unit, n is the number of tuber-units, where $q = 1 - p$
and where there is made an estimate

$$p = \frac{\Sigma x}{m\ n}$$

where x is the number (0,1.2...6) of plants affected by purple-top in each of the n tuber-units

TABLE 2. *The number of plants with purple-top by size of tuber-unit within the homogeneous rows of Farm A.*

Number Affected	Size of Tuber-unit						
	2 Plants	3 Plants	4 Plants	5 Plants	6 Plants	7 Plants	8 Plants
Row I							
0	0	0	16	1	5	0	0
1	1	1	20	2	15	0	0
2	0	1	3	1	4	0	0
3	—	0	1	0	3	0	0
Row II							
0	0	0	0	0	0	0	0
1	1	0	1	1	7	0	0
2	0	0	1	1	15	1	0
3	—	0	0	8	16	1	0
4	—	—	0	3	1	1	0
5	—	—	—	0	1	0	0
Row III							
0	0	0	1	3	4	0	0
1	0	1	3	7	4	0	0
2	0	2	0	7	16	0	0
3	—	0	0	1	11	1	0
4	—	—	0	0	4	0	0
Row IV							
0	0	1	1	1	2	0	0
1	0	1	7	3	3	0	0
2	0	0	11	7	3	1	0
3	—	0	5	1	5	0	1
4	—	—	3	3	3	0	0
5	—	—	—	0	3	0	0
6	—	—	—	—	0	0	1

extensive calculations of table 3, although fundamental, may be avoided by using the relatively simple index of dispersion, as discussed by Fisher (1932:71)[7] from which it is found that the observed distributions of table 2 show no tendency towards over-dispersion, *i.e.*, to have none or all the plants in a sampling-unit affected by purple-top, but a slight effect in the opposite direction although this effect is not statistically significant.

On Farm B, as has been previously shown, the rows were heterogeneous, but the corresponding quarters, across rows, reasonably homogeneous. Accordingly, to parallel the treatment for Farm A, the distribution of purple-top across rows by quarters for tuber-units was found, as in table 4. It was again found[8] that there was no evidence of over-dispersion, but rather a slight but not statistically significant tendency to under-dispersion.

The variability was not low to a significant extent, but it should be remembered that such an effect may have been obscured somewhat by a slight heterogeneity of the areas used, so that a tendency to under-dispersion may be obscured, and it may well be that it is real. To establish a biological hypothesis which should account for such an effect would, of course, be more difficult than to dismiss one, but it may be suggested that such an effect would arise if the mother tubers, when sub-divided, included regularly one part which would produce a plant inclined to purple-top. Any other mechanism, such as an insect which tended to space itself regularly along rows and which tended, therefore, to space out purple-top regularly, would be equally acceptable. Certainly, from tables 2 and 4, there is no tendency for one member of a tuber-unit to be affected by purple-top because a co-

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[7]Following Fisher (1932) the index of dispersion is

$$X^2 = \frac{\Sigma\,(x-\bar{x})^2}{\bar{x}q},$$

where

$$\bar{x} = \frac{1}{n}\Sigma x;$$

and reference is made to the standard tables X^2. For Farm A, such values of X^2 were calculated for each size of sampling-unit in each row and the results summed giving $X^2 = 215.20$ ($f = 243$) which is somewhat smaller than would have been expected by chance but not significantly so.

[8]For Farm B, within quarters of the field, the test of dispersion gives $X^2 = 471.98$ ($f = 483$), which is again a little small. If the results for the two farms are considered jointly, the results, although in the same direction, are still not significant.

TABLE 3. *The observed and expected number of affected plants in tuber-units of 6 plants within the 4 rows on Farm A.*

Number Affected	Row I		Row II		Row III		Row IV	
0	5	7.2	0	2.0	4	2.6	2	0.5
1	15	10.6	7	7.8	4	8.9	3	2.6
2	4	6.6	15	12.6	16	12.7	3	5.3
3	3	2.2	16	10.8	11	9.7	5	5.7
4	0	0.4	1	5.2	4	4.1	3	3.5
5	0	0.0	1	1.3	0	0.9	3	1.1
6	0	0.0	0	0.1	0	0.1	0	0.2

TABLE 4. *The number of plants with purple-top by size of tuber-unit within the fairly homogeneous quarters of Farm B.*

Number Affected	Size of Tuber-unit						
	2 Plants	3 Plants	4 Plants	5 Plants	6 Plants	7 Plants	8 Plants
				Quarter I			
0	1	8	44	19	16	2	1
1	0	2	12	9	10	1	0
2	0	1	2	1	0	1	0
3	—	0	0	0	0	0	0
4	—	—	0	0	0	0	0
5	—	—	—	0	0	0	1
				Quarter II			
0	0	11	42	34	16	3	0
1	0	2	10	5	2	0	0
2	0	0	1	1	0	0	0
				Quarter III			
0	0	11	51	34	17	0	0
1	0	0	7	6	4	1	0
				Quarter IV			
0	0	19	46	29	13	0	0
1	0	5	11	3	1	0	0

member is affected. Hence, purple-top cannot be simply contagious from a plant to its neighbor or be inherited.[9]

Summary

From a statistical study of the distribution of purple-top within tuber-unit plantings it is clear that the cause of purple-top may operate variously over a field but with similar freedom along and across rows of potatoes. There is, further, certainly no tendency for one plant to be infected as a co-member of a tuber-unit has purple-top; hence the condition cannot be simply transmitted from a plant to its neighbor. There is an uncertain suggestion, to the contrary, that a regular proportion of plants in each tuber-unit tend to purple-top, as might be the case if structure of the mother tuber, for each unit, were involved.

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[9]Dr. D. J. MacLeod, of the Dominion Plant Pathology Laboratory in Fredericton, N. B., to whom the present results were shown, has observed that the present statistical results agree well with his observations on a type of purple-top due to a strain (possibly aberrant) of the aster yellows virus. In the first place, of tubers from plants with purple-top, only about one in a hundred transmits the infection, at least in a typical, permanent form. In the second place, aster yellows is much more readily passed from plant to plant when there is alternation of species, in particularly potato and tomato, so that Dr. MacLeod is inclined to the hypothesis that in the field an alternation between potatoes and some weed occurs, and that the transmission of the disease from one potato plant to its neighbor may be rare.

AMERICAN SEEDSMEN AS VENDORS OF SEED POTATOES

E. V. HARDENBURG,

Cornell University, Ithaca, N. Y.

A century ago, most of the seed potatoes and nearly all of the new varieties were sold by catalogue seedsmen. The late blight disease, *Phytophthora infestans,* was widespread and of serious consequence. There was no known control and growers tried a great variety of cultural practices and soil amendments in the attempt to curb its damage. In the decade 1850 to 1860, Black Chenango, Blue Mercer, Blue Centennial, Lady Finger, and Cowhorn were among the varieties most widely grown in the East. Several European varieties were imported in the attempt to find varieties resistant to the plague. During the decade 1850 to 1860, the Reverend Chauncy Goodrich of Utica, New York, introduced the Rough Purple Chili from South America as parent seed stock from which he hoped to develop blight-resistant varieties. Although his efforts resulted indirectly in such important varieties as Early Rose and Early Ohio, these were in no sense blight resistant and blight control remained a problem until Bordeaux mixture was discovered as an effective fungicide.

As late as 1915, potato variety nomenclature in this country remained in a state of confusion. Then came Doctor William Stuart's classification of American varieties and the development of a nation-wide program for the production of certified seed. These two accomplishments did much to clarify the confusion in variety naming and to make comparatively disease-free seed stock available to growers. From this time on, catalog seedsmen have played a declining role in the market for seed potatoes. During this period, certified seed growers and seed growers' Associations have marketed an increasing proportion of the total seed crop. This is probably as it should be. Scarcely any recognized new varieties have been introduced by catalog seedsmen during the last 30 years.

AN ERA OF NEW POTATO VARIETIES

In a nation-wide attempt to develop higher yielding, more disease-resistant, more salable, and higher culinary quality varieties, we are now in an era of new varieties. Since the introduction of Katahdin by the United States Department of Agriculture in 1923, about 30 new varieties have been introduced by the federal government and at

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least 13 of the states. Several more can be expected soon. Of these, two can be classed as very early, five as early, eight as mid-season, twelve as late and three as very late. About two-thirds of them are at least resistant to one or more virous diseases, to blight, to scab or to hopper injury. Few, if any, are resistant to enough diseases to permit us to conclude that the breeder's task is near completion. Meanwhile the job of breeding new and better varieties is in the lap of the federal government and the state experiment stations rather than that of the seedsman who specializes in other vegetables.

The Role of the Catalogue Seedsman

The writer recently inventoried a random sample of American seed catalogs for varieties of seed potatoes listed in 1945. Of the 62 catalogs studied, only 30 or 48 per cent listed seed potatoes. The varieties listed by these 30 seedsmen are summarized in table 1.

Table 1. *Varieties of seed potatoes catalogued by* 30 *American seedsmen*

Variety	Times Listed	Seedsmen Listing Per cent	Listed as Certified Per cent
Cobbler	28	93	71
Chippewa	22	73	55
Katahdin	22	73	50
Green Mountain	21	70	67
Bliss Triumph	14	47	57
Sebago	12	40	50
Russet Rural	8	27	50
Warba	4	13	25
Spaulding Rose 4	4	13	50
Early Ohio	4	13	50
Early Six Weeks	2	7	0
Pontiac	2	7	50
Early Rose	2	7	50
Jersey Red	2	7	0
Sequoia	2	7	50
White Rose	1	3	0
State of Maine	1	3	0
Houma	1	3	100
Rural New Yorker	1	3	0
White Rural	1	3	0
Sir Walter Raleigh	1	3	0
Netted Gem	1	3	100
Burbank	1	3	100
Earlaine	1	3	100
Early Sunrise	1	3	0
Early Idaho	1	3	0
Salzer's Earliest	1	3	0
Earliest of All	1	3	100
Surprise	1	3	0
Blue Salad	1	3	0
Average	—	—	54

Only six varieties are listed by 40 per cent or more of those who handle seed potatoes, these being in order of importance Cobbler, Chippewa, Katahdin, Green Mountain, Bliss Triumph and Sebago. It is significant that varieties of the Rural type, originally very widely grown in the north central and north eastern states are now listed by only three seedsmen. About one-third of the varieties listed are either not standard or important, but these are carried by only a few companies. The weighted average proportion of all varieties, represented in this study, which were of certified stock is 54 per cent.

The quality of service rendered to potato growers by seedsmen perhaps can be best measured by the quality of the descriptions and illustrations found in their catalogues. The author's estimate of this quality is summarized in table 2.

TABLE 2. *Estimated quality of material in* 30 *seed catalogues* (*Per cent*)

Material	None	Good	Fair	Poor	Bad
Descriptions	10	13	37	20	20
Illustrations	33	27	10	27	3

From table 2, it can be seen that about 40 per cent of the descriptions and 30 per cent of the illustrations are either poor or definitely bad. In arriving at this conclusion, material that was of no value, in error, or definitely misleading was judged to be less than fair in quality. There can be little or no benefit to either seedsman or grower in merchandising odd or little known varieties. Illustrations which do not serve truthfully to picture the characteristics of the varieties shown are not only misleading but also a useless expense. Seedsmen who feature seed potatoes may well stock only certified seed in the interest of building better business. College and experiment station workers should strive more fully to cooperate with seedsmen in furnishing better catalogue material.

SECTIONAL NOTES

NEBRASKA

The final or bin inspection on Nebraska Certified Potatoes is practically completed at this time. It indicates that one of the best quality crops on record has been produced. Fortunately, the yields are also very good, and this combination with the price and market situation being as it is, will work to the advantage of the grower. Average yields

on the dry land are somewhat better than usual. Many growers exceeded 150 bushels per acre,—with an occasional field exceeding 200 bushels per acre. In view of the fact that 100 bushels are considered average, this is very good. Where the fields are irrigated, there is probably a lighter yield than normal. In this case, many yields run more than 400 bushels per acre in the average season, but very few have reached that point this year. The majority of the good fields are in the neighborhood of 300 bushels per acre.

The sales agency of the Nebraska Certified Potato Growers' Cooperative reports well over one-half of the anticipated crop already contracted for shipment. The actual movement of certified seed potatoes began in the early part of November. These early shipments went to the lower Rio Grande Valley of Texas, and such shipments have continued to date with the bulk supposed to be moved before Christmas. Other shipments will get under way shortly after the first of the year.

Table shipments have continued at a steady rate through the season, with prices varying according to the shipments on the market. Generally speaking, these table stock shipments have been U. S. No. 1 grade. Low grade potatoes being less than usual, are selling readily enough.

Up to this writing, there has not been a great deal of interest in the loan program offered by the Government. This is not understandable, in view of the Government report of a large crop throughout the country. In view of the fact that this is the only way growers may take advantage of the support price, various agencies have been urging the growers to take these loans. It is possible there will be a last minute rush on the part of the growers to make application for loans.

It is entirely too early to hazard a guess on the possible acreage for 1946. Growers who have contracted all or part of their crop, seem reasonably optimistic, and think they will maintain the same acreage they had this season. There has been a very good sale of Foundation Seed Stock locally, also indicating that the acreage of certified potatoes will be kept up at a good point this coming year. In view of the fact that the supply of Foundation Seed is generally limited, this may not be more than the usual demand for the time of the season. In the opinion of the writer a good many things can change the present picture before the next planting season. The price obtained for the bulk of the present crop, the Government moves on control of succeeding plantings, and the agricultural price situation, in general, will have significant effects on this coming year. (Dec. 1)—MARX KOEHNKE.

NEW JERSEY

The Government has completed its program of price support for potatoes in New Jersey. All of the bulk potatoes that were placed in temporary storage have been moved, as well as the second size potatoes that had accumulated on many farms. Most of our growers were very critical of the price support program early in the season but they now feel that the Department of Agriculture, through its various departments which handled the difficult task of disposing of some 3,000 cars of surplus potatoes did a good job. At a recent meeting of the executive committee of the State Potato Association it was voted to send a resolution commending the agencies for their splendid work.

The annual meeting of the New Jersey State Potato Association will be held in Trenton, on the 24th of January. The meeting will start at 10:00 A. M. and will continue through the day. A very interesting program has been arranged. An open forum in the afternoon will be devoted to discussion of "The Future of the Potato Industry in N. J." In the evening the Potato Growers will have a banquet with professional entertainment and dancing. (Dec. 8)—J. C. CAMPBELL.

NEW YORK

There seems to be a general feeling among New York potato growers that the remainder of the 1945 crop is no larger than can be disposed of profitably in a program of orderly marketing. The Western New York crop was reduced from earlier estimates by blight, hopperburn, bad weather at harvest and inability even to complete the digging operation on many farms. A larger than normal part of the crop will probably rot in storage because the tubers were wet, muddy, blighted and some were even frozen when they went into storage.

The opposition situation prevailed on Long Island where an excellent quality crop was harvested under good conditions. Here fewer potatoes were stored than usual because of the Government program of diversion and direct purchase. Since some of the available surplus of the Northeast is being shipped to Western Europe to relieve the food shortage there, it is not likely that there will be any backlog of supplies next spring.

On the 26th and 27th of November, many potato growers assembled at the College of Agriculture to discuss problems of the certified seed grower. Incidentally, the Brewster Bill now pending in Congress, was brought up for discussion. There seemed to be almost a unanimous opinion that such legislation would be not only unnecessary but prob-

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ably detrimental to the potato industry in the postwar years. It is realized that government support cannot continue without government control of acreage and production. Nevertheless such programs tend to encourage the small inefficient grower to stay in business as he does not feel the need to do any planning himself and knows the government is carrying the risk. The recent trend in New York has been toward a decline in total state acreage, toward larger acreages on fewer farms, and toward extension of the industry to better soils and away from poor soils. This is a desirable trend. The Brewster Bill would tend to force a reduction in acreage where it should be expanded and encourage production where it is least desirable in New York. (Dec. 4)—E. V. HARDENBURG.

OREGON

Potato shipments have been heavy to date and many contracts made at ceiling prices have been fulfilled. In general, prices have remained at ceiling levels even after the ceiling was suspended. Lower grades, however, have followed a very appreciable decrease. It is generally estimated that carlot shipments will be at least one thousand cars less than the 1944 shipments, notwithstanding a 5 per cent increase in acreage.

The general sentiment of growers seems to be that a regulated acreage should be established, as the heavier crop, with consequent reduced prices in the face of heavier than ever production costs and limiting regulations, would be ruinous to the industry.

Demand for certified seed continues heavy throughout the area. (Nov. 24)—C. A. HENDERSON.

PENNSYLVANIA

There were 1,801.3 acres of potatoes inspected for seed certification during 1945 compared with 1,955.35 acres inspected in 1944. Last year there were 1,067.95 acres certified compared with only 775.7 acres certified this year. There are several reasons for the lower acreage certified this year compared with 1944. The principal reasons for this reduction were: Fewer acres entered for inspection, heavier than usual rejections, because of diseases found during the growing season, and a lower average yield per acre of 30.7 bushels as compared with 1944.

Although the crop inspected this year showed higher disease counts than usual, the market quality of the crop harvested is estimated to be considerably above the average of recent years.

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Varieties certified in their order of importance are as follows: Katahdin, Sebago, Russet, Green Mountain, Houma, Menominee, White Rural, Nittany and Sequoia. Although the Russets and White Rurals were being replaced somewhat during the past several years by the Katahdin and Sebago varieties, fewer acres of Russets and White Rurals were certified because of a higher percentage of rejections. Katahdins and Sebagos are more resistant to certain virus diseases that Russets and White Rurals are highly susceptible to.

Last year 45.3 per cent of the total acreage entered for inspection was rejected. This year 56.94 per cent of the total acreage inspected was refused certification.

Seed potatoes were certified in twelve counties of the state as follows: Berks, Erie, Indiana, Lehigh, Mercer, Potter, Somerset, Sullivan, Tioga, Warren, Wyoming and York.

Pennsylvania ranked fifteenth in the production of certified seed potatoes in 1944 among the thirty states that are producing certified seed potatoes. This state ranked first in the production of White Rurals; second in Russets; third in Sebagos, fourth in Katahdins, Houmas and Sequoias. (December 5)—PENNSYLVANIA DEPARTMENT OF AGRICULTURE.

VERMONT

Requests for only four or five loans under the government price support plan had been reported in Vermont to the eighth of December, the deadline for filing applications. The several applicants, with one exception, were in the larger grower class varying from 40 to 100 or more acres.

Plans are beng formulated for a basic foundation seed production plan. Tentative arrangements include the growing of a two-acre plot at the State School of Agriculture, Randolph Center, under supervision of the Department of Agriculture with collaboration from the State Experiment Station. Early harvesting will be practiced. Naturally the strictest sanitary measures will be enforced to prevent danger of ring rot. Provision will be made for increase plots under similar supervision in 1947. The extreme sweep of leaf roll during the past two years together with ring rot infiltration has made supervised foundation stock production a "must." (Dec. 8)—H. L. BAILEY.

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WASHINGTON

Our potato crop has mostly been harvested. We lost a small acreage because of excessive rainfall during the latter part of October and all of November. Our potato crop, in general, was about average. Our certified seed potato acreage was larger this year than last, but the production per acre was less. The total crop, however, was somewhat larger than the 1944 production.

All of the White Rose variety has been marketed and the majority of it shipped to the buyers. Most of the White Rose went to California and to Oregon.

We have just completed the planting of the winter test plots at Oceanside, California. The western states and British Columbia have joined with California in testing out seed lots at this southern location. This makes possible the reading of disease content sometime in February. We are using this plot to determine the eligibility of certain lots for certification and also for the purpose of testing our 1946 planting stock.

With the increased demand for disease-free, high quality foundation seed it is necessary that we use every available opportunity to produce better seed. The Netted Gem, or Russet Burbank has been involved in what I would choose to call a leaf roll complex that has resulted in a rapid decrease in acreage of this variety. Unless through the use of D.D.T. as an insect control and incident disease control, or some other method of satisfactory dealing with this complex, the production of Netted Gems may pass out of the picture within the next few years. (November 27)—CHAS. D. GAINES.

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